AMERICAN FRUITS

SAMUEL FRASER

1925

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AMERICAN FRUITS

Their Propagation, Cultivation, Harvesting and Distribution

By

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DEDICATED

To My Father and Mother

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SAMUEL FRASER.

Geneseo, N. Y.
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AMERICAN FRUITS

INTRODUCTION

Many points are often overlooked in fruit-growing and farming. One of these is the overhead expense. Farming has been carried on so long that if one attempts to reduce the overhead, he may reduce the efficiency of himself and of his farm.

Agriculture an old industry. Agriculture is different from many other lines of industry. For one thing, it is older. It has been practiced for ages; whereas railroads are the product of two generations at most; wireless came in this generation; automobiles, steel works, telephones are modern, and electricity is quite recent. Most modern lines of engineering, transportation and distribution are so new and the methods often so crude and frequently inefficient, that it is easy for thinking men to devise means for reducing costs. Men amass fortunes by becoming efficient in one line. Some industries are so raw and new that it is easy, relatively speaking, to make money. On the other hand, and contrary to the often-expressed opinion, agriculture is the most highly efficient of all industries and is not a fertile field for amassing money. Compared with large city enterprises, farming is a small business and highly specialized. It requires experience and even then the returns are modest.

Fruit growing a new industry. Fruit growing is of more recent origin than the production of meat or milk or hay or wheat. It has been only recently commercialized. It, therefore, lends itself to a process of readjustment.

Cost of production. There is much misinformation about the cost of producing things. During recent years much has been written on the cost of producing milk. In many of these cost accounts it is quite common to find missing a dozen items of expense. The industry is operated on a small margin and the small amounts constitute the whole of the profit. The point to consider, is whether we know what we are doing and whether we know what it is costing us. It is probably right that the public should know in time what it does cost to grow things, but before the public can know, the grower must. There is no use passing out data which are only 80 per cent correct.

Adequate data as to the cost of growing fruit cannot be secured in a ten-year period; it is a long-time job. A severe winter like 1917-18 may wipe out an established apple orchard in New York, where commercial apple growing is longer established than anywhere else. At intervals, how frequently no one knows, the citrus and semi-tropical fruit industry of Florida may be destroyed. A series of poor years may use up all the profits made during a previous decade. There is no certainty. The duration of life of a tree is unknown.

Slow turnover of capital in fruit growing. After trees are in bearing, there is but one chance for a crop in a year; or in two years if the tree is a biennial bearer. Furthermore, we may have to grow an apple or a pear tree ten years before it begins to bear. Again, the apple harvested in October must be held in storage if we would eat apples in May. The fruit-grower's distribution and storage problems are intricate and can be solved only by the united effort of all interested. The more generally fruit is produced, the more easily will we overcome our harvest and distribution problems. There is reason for the home-production of the fruit by every family living in the country. It is a liberal education to learn how to grow fruit. The nation well supplied with fruit-bearing trees is rich. An investment in an orchard well located, with proper varieties adapted to the conditions, is a valuable legacy to children who know how to care for and appreciate it. The stability of character of any people goes with a foothold on the soil.

Prices are fixed by supply and demand and the surplus grown, not by cost of production. The commercial fruit grower must remember that his branch of farming is of recent origin. Until fifty years ago apples were grown principally for cider making; few were grown commercially for consumption as food. There were no large apple orchards on the Pacific Coast even twenty-five years ago; now half of our commercial production comes from these Western states. The production of apples in New York and Pennsylvania was largely a matter of chance, as it now is on the bulk of the farms. It is still true that a record crop of apples (one of those estimates in which all apples of all grades are included) is not made on the production of the well-cared for orchards. The trees on Tom, Dick and Harry's lots are bearing a crop and also are included. The sale price of apples is not based on cost of production or even on the low cost of production of the surplus, but on the selling price of bananas grown in Costa Rica and of oranges in Florida, California and Palestine. The strawberry crops of Louisiana and North Carolina aid in fixing the spring prices of storage apples. It is the surplus of all these and other crops, coupled with the demand both home and export, that decides the price.

Problems attending congestion. When the fruitgrower puts 100 acres of apple trees in a block, he runs into the difficulties attending a concentration camp: the diseases, cost of maintaining sanitation and feeding appear to be exorbitant. They do not appear to exist where two or three trees stand alone. When misfortune attends the crop on the few neglected trees the loss is small, but let disaster overtake the 100-acre plantation and much is lost.

Increasing yield is economically possible only when price is increased. In fruit growing, under normal conditions, we still compete with surplus products which cost little—with dates from Oman and Mesopotamia, oranges from Palestine, olives from Spain, lemons from Sicily, nuts from Serbia, Roumania and Algiers: all gathered at little expense from trees which cost practically nothing to grow. The main expense is the harvesting, packing, transportation and marketing. Economical methods of production and distribution are fundamental for success in fruit growing. High farming is justified only in times of high prices and the remedy for low prices is the reduction of costs and output by restricting production to the areas best adapted to the particular crop.

Increasing the yield per acre will not produce cheaper food. Nature produces food at the lowest cost when left alone. When we plow 6 inches deep it costs money; when we plow 10 inches deep it costs 50 per cent more and does not produce proportionately a larger yield. The last bushel of wheat produced on an acre, like the last pound of meat put on a fattening steer, costs the most. The high-priced, extra-fancy box apple is not necessarily the most remunerative to grow. It may be; again it may be high priced because it has to be. Today, with many fruits, 70 per cent of the consumers dollar is used to defray the costs of bringing the fruit from the tree to the consumer, and except in years of short crops, none but fancy grades will pay to ship, except to local markets.

Fancy products necessitate a special market. It we want to produce high-priced fancy products, we must cultivate a market for them, in which event a product grown fundamentally for food enters the realm of artificiality where a third of the amount received for it is expended in making the purchaser want it. The cost of production is so small a factor that it is negligible. This condition is seen in many lines, but it will never make cheaper food.

Land prices and land values. Data shows that the average American farm turns its capital over once in four to eight years, that 5 per cent income on capital invested is very high pay for managing a farm. In other words, an investment of $20,000 would not warrant the payment of more than $1,000 a year salary to the manager, who would also have to be a worker on the farm. The average investment per farm in the United States in 1910 was $6,444 and in 1920 $12,084, so that the farmer's income was bound to be small. The costs of production will be of interest if we can use them. We cannot reduce them much. The region with a low value on land is favored, for rent is a large and fixed overhead and in itself is a large profit.

Europe could not compete in wheat production with rent-free land in our Middle West fifty years ago; neither can we, now that we have high-priced land, compete with almost rent-free land in Siberia and the Shire Highlands of Africa when these are put to work. There is no reason for farmers to put land prices up. The real estate agent may gain by doing so, but to the farmer such increases are a loss. Land prices are often local and are not true land values. Land prices have been much inflated in some fruit-growing sections, with the result the industry is injured.

The importance of interest on capital is shown by the cost of producing a box of apples. In 1920 the cost of producing a packed box of apples in the Wenatchee district, Washington, not including interest on capital or labor income, was $1.97. The interest or rent of the land and equipment at 8 per cent on a valuation of $1,500 per acre was 53 cents per box more, and the average sale price f. o. b. of the box of apples was $2.01. Interest on capital, if paid, is over 21 per cent of all costs in this instance. In New York the author found an instance where

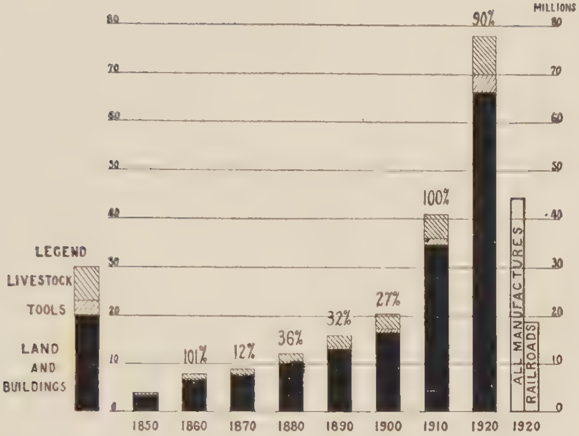


FIG. 1. Capital invested in American Farms 1850-1920. Showing the amount in land and buildings, tools and livestock, also the amount invested in all manufactures and railroads for 1920. From U. S. Census. The handicap on the new generation of American farmers paying interest on this huge capitalization will be apparent. With deflation of the price of farm products since 1920, the valuation of American farms must also decline and during the two years 1920-22 it is estimated that this decline amounted to 24 per cent

$250 were expended during a nine-year period in planting and bringing an acre of apple orchard into bearing. This did not include the purchase price or rent of the land or interest on capital or any income for the owner. The sum of $150 more had been required to meet the items of rent and interest on capital. In other words interest charges may constitute 37 per cent to 42 per cent of the expenditure.

PART I

POME FRUITS WITH PARTICULAR REGARD TO THE APPLE

CHAPTER I

PROBLEMS OF THE YOUNG FRUITGROWER WITH PARTICULAR REGARD TO THE APPLE

Capital. The first problem confronting the young man is capital. Expenses are increasing every year. Land is not free, it must be bought. Buildings demand repairs; labor has more than doubled in cost. Labor-saving machinery is frequently special-purpose machinery; it is used on one or two occasions only, and it is costly.

In apple-growing, the capital may be locked up seven to fifteen years, with hope deferred as the only dividend; in peaches three to five years; pears and many of the nuts seven to fifteen years; cherries, plums and citrus fruits at least five years. In small fruits, a little over a year in the case of strawberries in some sections; two or three years with raspberries; probably four or five years in the case of currants and gooseberries. It is not a milk business with two daily harvests and a daily sale. With a bearing apple orchard it may mean 15 sales in thirty years, and that is a lifetime, the age of a man from thirty to sixty. Waiting is an important factor in the production of all farm crops and particularly so in fruit growing, and by waiting I do not mean the expenditure of so many years of time alone, but in addition one must have a reserve of capital which can be drawn upon and used each year during the period of waiting, and sufficient faith in the project to expend it. This annual supply of capital must either be secured from a capital account or it must be earned annually. The poor man does the latter, and, if he fails to secure it he may lose out on his venture. It is no small matter to plant an orchard and bring it into bearing.

Knowledge, wisdom, common sense and longevity are essentials. To succeed one needs more than capital. Money takes wings; it flies away. One needs knowledge. To learn what to do and when, is knowledge. One needs wisdom to direct his knowledge, and lastly, common sense. Given these, the fruit grower needs longevity to get the chance to use them. It is a great fight, with a reward "for him who endures to the end"; an endurance test. There is no great wealth, but a living is assured if one is successful.

Location. "North, East, South or West, hame's best." If one lives in Hood River or Wenatchee, it is a privilege to stay there. If in Pennsylvania or New Jersey and one wants to grow apples, locate in Pennsylvania or New Jersey. Stay at home. Stay near the wonderful markets, near the low freight rate to seaboard and to the purchasing public. We live but once; live as you go. Don't get the idea that you must accumulate money before you can be happy. You may get all the money in some other line and then it may fail to procure happiness. The fruit grower has a chance to live, if he enjoys his work. Incidentally, when determining the location for commercial fruit growing, consider the following:

Is the production of the special fruit under consideration established and well organized in the district and sufficiently remunerative to class it as a business?

Is the district free from late frosts, cloudy, rainy weather at time of bloom, and injurious winds at harvest time?

Is there an adequate water supply to grow the crop and, in the case of tree fruits, a cover crop at the same time? Some western orchardists would not like to locate where they would have to depend on nature for the soil's supply of moisture.

Are there good highways to market and to the railroad, and is the transportation service adequate?

Are the schools, churches and social life of the community on a high standard?

In other words, consider seriously: Is there a chance to make good at the business and for a family to live?

Advantages of the East for Apple growing are:

1. The business is longer established.

2. There is more data in regard to varieties and local conditions.

3. Land is cheaper than in the far West.

4. Markets are nearer; everything has a sale value, the best and culls; in the Far West nothing but the best can be shipped at a profit; C grade apples are sometimes shipped but they rarely pay the costs attending transportation and distribution; they do not pay to grow.

5. Until recently, labor has been cheaper in the East.

6. The trees are longer lived.

7. The fruit is better flavored.

8. The freight rates are less.

9. Usually there are several competitive channels through which the commodity may be sold.

The situation of the Eastern grower:

1. He will experience keener competition from the West, especially on the higher grades. To meet this the hope is in the young trees, not the old established orchards. Old orchards will produce average fruit, not fancy. Trees may need to be scrapped earlier.

2. The western growers are organized, of necessity. With near-by markets, there is not the necessity for the eastern grower to do so. The western grower is using co-operative effort in various ways. Frequently it is not recognized as such, but it is true co-operation of growers and distributors to ensure the best possible distribution, by means of advertising, grading, packing, selling,—hence the eastern man will have to fight harder to hold what he has. Collective bargaining and organization methods are both established in the East, but the proximity of the individual grower to the market renders it possible for the individual grower to co-operate with or sell direct to the individual distributor, carlot receiver, jobber or commission merchant in a way which assures the grower the maximum return, and many growers follow this system.

3. The growers in the Central states are working to secure the benefit of their central position, better freight rates, as well as to grow and pack better fruits.

4. The East receives a good share of the 50,000,000 bunches of bananas, 100,000 to 140,000 carloads of apples, 100,000 cars of citrus fruits, 30,000 cars of peaches, 10,000 to 15,000 cars of pears, which affect the sale of early apples; also plums, cherries and 30,000 to 60,000 cars of grapes. The early strawberry crop affects the price of late winter apples. Twelve thousand cars are our normal average rail movement. Once a consigned car reaches a market, it must be sold, and usually it is good policy to take the market price on arrival. Cost of production has nothing to do with the sale price. The surplus of a perishable commodity quickly fixes the price of the whole crop, and frequently of other crops in competition with it. These are all important items in determining the success of an individual who has but limited means. The weather, business conditions and other related and sometimes apparently unrelated factors enter into the determination of success or failure.

Grading and packing, to meet eastern grading laws and at the same time keep the price reasonable, demand the use of machinery, if apples are grow commercially. There are many graders; generally speaking, they reduce the cost of handling. A packing shed is in order. For the small grower, away from a local market, and where there are few cash buyers, and one has to ship his fruits, the cooperative or community packing plant may be advisable.

Professor Waugh's advice to fruitgrowers and to those about to go into it is: "Get all the advice you can, usually it costs nothing and it's worth it." While discussing advice, I would urge that one do not attempt too much. Most of us plan to plant three times the area for which we have money to spend and time to give. The individual tree is the unit. If a man has not time to personally examine his trees, he is losing most of the fun there is in the game. Some men secure as much revenue from a single tree as others do from an acre of orchard. While they do not loom so large on the landscape, they may be more comfortable. "Whatsoever thy hand findeth to do, do it with thy might," is the only basis on which one should begin as a fruitgrower.

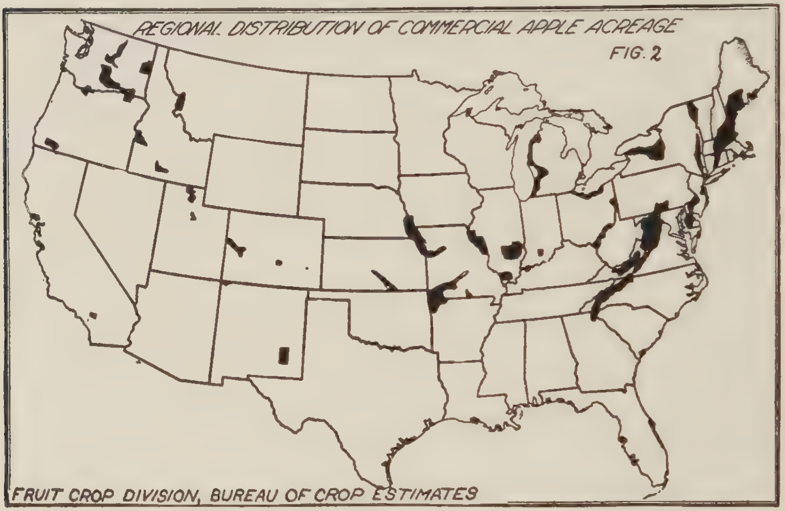

REGIONAL DISTRIBUTION OF COMMERCIAL APPLE ACREAGE

FIG. 2

FRUIT CROP DIVISION, BUREAU OF CROP ESTIMATES

Where apples are grown commercially. While apples are grown for home and local use almost all over the United States, there are certain fairly well-defined regions in which the commercial production of the crop is of importance. In the Eastern states, the crop is usually moved in barrels; an increasing amount is handled in bushel baskets, and some in bulk.

New York leads all states with about one-fourth of the total production of the country, the industry being most highly developed along Lake Ontario in Niagara, Orleans, Monroe and Wayne counties. The Hudson River and Lake Champlain are important regions. Baldwin with 40 per cent and Rhode Island Greening with 20 per cent of the total production, are leading varieties.

Maine, Massachusetts, Vermont and New Hampshire are the leading New England states in the order named. The normal production of New England is about one-fourth that of New York. Baldwin is the leading variety.

The Shenandoah-Cumberland apple region, embracing Southern Pennsylvania, the Cumberland region in Maryland and Shenandoah in the Virginias, has a normal production of about one-third that of New York and is increasing rapidly. York Imperial and Ben Davis predominate. Scattered districts are the Albemarle Pippin region in Virginia and mountainous regions of western North Carolina and northern Georgia.

In the Central states the crop is moved in barrels, baskets and in bulk. Michigan is in this group, but in regard to varieties—Baldwin, Northern Spy and Rhode Island Greening—it is similar to New York. It has a crop usually about one-fourth that of New York.

Illinois is a heavy producer, especially in the southern portion of the state. The Ozark region of southwestern Missouri and northwest Arkansas is a heavy producer of Ben Davis, usually securing a crop about one-ninth that of New York.

The Missouri River region, embracing an area in Iowa, Missouri, Kansas and Nebraska, has Ben Davis as its typical variety and produces about two-ninths as much as New York.

The Western states ship their commercial crop mainly in boxes, Washington is the leading state in the group, with 50 per cent of the total production, followed by California, Oregon, Idaho and Colorado. The western apples are usually grown in small irrigated regions under intensive cultivation. The eastern fruit is grown over a much greater territory and much of the crop is produced with little expense and is of little commercial importance; it is not stored and does not affect the winter apple trade, whereas the western crop is grown and packed in the main for the winter apple trade. In 1921 the bushel basket was used for the movement of part of the Idaho crop, a few cars were moved in barrels and a considerable quantity in bulk.

Commercial production. In commercial apple production, Washington leads, New York is second and Virginia third. It is well to appreciate that we have not yet developed the proper state of mind in regard to the western crop. When the crop of apples was located largely in the East, as it was in 1918, the situation was not difficult to size up, but when it is mainly in the West, as it was in 1919 and again in 1921, the crop movement is not started at a right price. It begins at too high a price in the fall, and stagnation follows. We must develop a state of mind which can visualize a western crop. The man is wise who recognizes a high price when it is offered, and sells, but no sale is of permanent value to the industry unless it is a benefit to all concerned.

Present condition of the industry. A large portion of the apple trees in New York are forty or more years of age. Many feel that that state is approaching its maximum production. Indications are that the state has been planting about enough trees to maintain itself at its present volume or even to increase it, because the new plantings are commercial orchards. In the Shenandoah-Cumberland region there is likely to be an increase in production. In the Pacific Northwest we must look for an increase, and this will, perhaps, be increasingly felt in the next decade, unless some catastrophe happens. The state of Washington, in 1895, was absolutely a negative factor; in 1900 it was relatively unimportant; in 1917 it produced 20 per cent of the total United States crop and was the greatest commercial apple-producing state in the Union. The main production was in the Wenatchee and Yakima Valleys, these two regions shipping over 22,000 cars and 16,000 cars respectively in 1919, while about 55,000 cars of apples were moved in the 1921-22 season from the western or box states.

Relationship of the commercial crop to the total. The commercial apple crop is about 40 per cent to 48 per cent of the total produced. The United States Department of Agriculture began to gather data on the commercial crop in 1913 and estimated that about 41 per cent of the total crop grown was commercial; in 1914 the estimate was about 38 per cent of the record production of 84,400,000 barrels; in 1915 the estimate was placed at 56 per cent, but many believed that it did not exceed 40 per cent of the total crop of 76,670,000 barrels. Government estimates of both total and commercial crops for the five years,—from 1916 to 1920,—show that the commercial crop was 44 per cent of the total crop.

TOTAL AND COMMERCIAL APPLE CROPS OF THE UNITED STATES

Year	Total crop in barrels	Commercial crop stated in barrels*
1916	64,635,000	26,747,000
1917	55,583,000	22,341,000
1918	56,541,666	24,743,000
1919	51,079,333	26,223,000
1920	80,147,333	36,272,000
5 year average	61,597,266	27,265,200

* Stated in barrels means that three boxes were estimated as equal to a barrel and this total was added to the actual total of barrels.

PRODUCTION OF APPLES IN UNITED STATES (1916-19)

State	Commercial crop barrels		Total crop barrels	Percentage of commercial
1. Washington	5,062,600	(2)*	6,431,000	79
2. New York	4,132,000	(1)	9,106,000	45
3. Virginia	1,785,000	(4)	3,758,000	47
4. California	1,246,000	(6)	2,435,000	51
5. Michigan	1,133,000	(5)	2,531,000	45
6. Illinois	1,045,000	(10)	1,731,000	60
7. Pennsylvania	988,000	(3)	4,526,000	22
8. Missouri	916,000	(8)	2,008,000	46
9. West Virginia	892,000	(9)	1,784,000	50
10. Oregon	886,000	(11)	1,430,000	62
11. Colorado	683,000	(21)	851,000	80
12. Ohio	629,000	(7)	2,014,000	31
13. Idaho	589,000	(20)	844,000	70
14. Kansas	500,000	(25)	705,000	71
15. New Jersey	493,000	(23)	757,000	65
16. Arkansas	476,000	(22)	809,000	59
17. Maine	441,000	(12)	1,334,000	33
18. Massachusetts	307,000	(17)	940,000	33
19. Indiana	304,000	(16)	974,000	31
20. Maryland	279,000	(24)	757,000	37
21. Vermont	207,000	(26)	588,000	35
22. North Carolina	186,000	(13)	1,232,000	15
23. Iowa	182,000	(18)	897,000	20
24. Delaware	169,000	(36)	224,000	75
25. Nebraska	164,000	(32)	398,000	41
26. Tennessee	161,000	(15)	1,173,000	14
27. New Hampshire	157,000	(29)	441,000	36
28. New Mexico	156,000	(35)	298,000	52
29. Utah	123,000	(37)	214,000	57
30. Connecticut	117,000	(28)	466,000	25
31. Wisconsin	117,000	(19)	883,000	13
32. Kentucky	115,000	(14)	1,208,000	10
33. Georgia	101,000	(27)	474,000	21
34. Montana	86,000	(34)	324,000	27
35. Minnesota	51,000	(30)	435,000	12
36. Oklahoma	35,000	(33)	344,000	10
37. Texas	24,000	(38)	144,000	17
38. Rhode Island	22,000	(40)	78,000	28
39. Alabama	20,000	(31)	404,000	5
40. Arizona	16,000	(41)	46,000	35
41. South Dakota	4,000	(39)	105,000	4
United States	25,001,000		56,502,000	44

* Figures in parentheses rank states in order of importance in total production.

No decline of commercial crops. Owing to a decline in the average farm orchards, especially in the eastern part of the country, we may expect a decline in the total production of apples. This, however, will not affect the commercial crop. With our present commercial apple acreage, the number of apples which reach the market may be expected to increase. The increase will depend on whether the industry is profitable or not. If it is not, there will be a tendency to neglect the orchard on the general farm, which will reduce production. There is a general belief that taking a period of years, which is the only way in which an apple orchard can be considered, and taking the acreage as a whole, the apple crop has not made better returns than the average farm crop. Yet it affords opportunity for individuals who are exceptionally located to make a good income.

Commercial apple crop in Canada. As with the United States, the eastern portion of Canada uses the barrel as the standard package. Much of the fruit is of but average quality and is comparable with that grown in New England and the Eastern States.

Nova Scotia leads in production. The commercial crop for the period 1910-21 is shown below, also the number of barrels exported.

PRODUCTION AND EXPORTS OF APPLES FROM NOVA SCOTIA 1910-21

Year	Production in barrels	Exports in barrels
1910	323,000	248,000
1911	1,734,876	1,408,700
1912	993,523	801,000
1913	651,390	519,582
1914	981,437	752,500
1915	613,882	416,500
1916	681,470	416,808
1917	744,730	13,700
1918	806,600	271,170
1919	1,500,000	492,180
1920	1,160,000	900,276
1921	1,300,000	1,120,070

Quebec, New Brunswick and Prince Edward Island. The crop is grown for local use only. In 1919, New Brunswick shipped some 20,000 barrels of apples. The severe winter of 1917-18 set the industry back seriously.

Ontario. The average production of this province has been estimated at 2,000,000 barrels in the past but in 1918-19 it was not over 40 per cent of the average. The industry declined in the years 1914-19, due to labor conditions and severe winter injury. The export trade is of prime importance in Canada. The total exports for the years 1910-21 are given in the table:

Exports of Apples From Canada, 1910-21

Year	Exports in barrels
1910	523,658
1911	1,664,165
1912	1,324,769
1913	947,382
1914	1,117,336
1915	557,451
1916	570,854
1917	103,626
1918	405,058
1919	2,724 000
1920	3,205,000
1921	3,325,000

British Columbia. The apples are shipped in boxes. A very high percentage of the crop is commercial. The development is rapidly increasing. The figures following are based on the car movements and represent the commercial crop:

Production of Fruits in British Columbia, 1910-21

Year	Boxes of apples	Cars, other tree fruits	Cars, small fruits
1910	189,000	—	—
1911	225,180	—	—
1912	386,640	—	—
1913	457,380	315	128
1914	615,600	435	198
1915	993,060	355	166
1916	1,367,310	494	189
1917	1,785,370	470	184
1918	1,343,451	782.5	290.7
1919	2,234,000	892	399.2
1920	1,513,600	10,305 tons	2,237 tons
1921	3,030,000	14,294 tons	5,048 tons

Arrangement of labor. The beginner should prepare an outline of procedure. To do this intelligently it will be worth while to study carefully the labor requirements of crops that there may not be too much conflict. Some assistance can be secured by studying various records, showing the actual amounts of labor which have been used in the past in the production of these crops. For instance, late potatoes may need digging about the time that apples need harvesting, but cabbage might safely be left until the apples are gathered; hence we find in New York more apple men growing cabbage than we find growing potatoes. The harvesting of red currants may come at the time of haying. The work of spraying may interfere with the seeding of some of the spring crops. The best conceived program may be seriously disarranged by the weather, even if some allowance is made for this factor. We are usually apt to attempt more than we can carry out.

Labor income. One of the most important things for fruit growers, as well as for all farmers, is to secure the largest amount of money for their labor. Apples may show a net income of $50 an acre. Hay may show an income of $10 an acre, and yet it may be wise for the farmer to plant no more apples. On one farm of 90 acres, in 1909, there were 45 acres of tillable land. The receipts from the crops were as follows:

ORCHARDS VS CROPS; RECEIPTS AND PROFIT PER ACRE

	Receipts per acre	Profit per acre	Profit per hour of labor
Orchard	$101.75	$38.28	$0.23
Oats	26.42	6.84	.33
Timothy Hay	15.67	6.37	.63

If we look at the factor of receipts per acre, it might appear wise for the farmer to plant more apples, but when we consider the profit per hour of labor, we find the most money was made on hay. At the time, labor was paid 18 cents an hour, so that the income from 10 hours of labor was $8.10 in the case of the hay and but $4.10 from the apple orchard, and the year was an extra good one for the orchard and an average year for the hay and oats.

Crops grown should be adapted to conditions. Investigations show that there is no type of farming regularly more profitable than another type, but they do indicate that there are districts or regions in which each type should be developed. Whether we shall plant apples or oranges or grapes or strawberries or cotton or hay or corn, is largely a matter of adaptation to conditions. Each has a place.

Cycles of production. The production of almost every commodity grown on the farm has been entered into in a more or less erratic manner. We do not maintain a uniform rate of progress in planting, and this, perhaps, is better illustrated than explained.

M. C. Burritt secured the date of planting the apple trees in one township in Monroe County in New York, and this indicates the situation so well that we reproduce it. At the time of making this survey, 57 per cent of the apple trees were found to have been planted between 1859 and 1878, in 20 years. Only 11 per cent were planted between 1879 and 1903, the next 24 years. From 1904 to 1908, a period of five years, 21 per cent were planted, and we know that from 1914 to 1920 the planting of apples was again reduced to a minimum. Unfortunately, we have not a record of the districts of the United States in this way, and, if obtained, the data would need careful tabulation and elaboration, because the age at which the trees come into bearing in different localities varies, and their life varies, so that the data would not mean much unless all the facts were known, but it would be valuable if each commercial district were tabulated in this way. Such data are available for the Western states.

The rate of planting in Virginia. Virginia reported 2,185,000 commercial apple trees in 1917. The ages of these trees reflect the ideas of the growers.

Ages of Apple Trees in Virginia in 1918

Trees	Years planted	Per cent
717,605	1-6	33
588,483	7-12	27
540,218	13-18	25
215,324	19-24	10
92,422	25-30	4
16,855	31-36	1
8,275	37-40	
5,024	Over 40	

This table shows that Virginia is making substantial cumulative gains. Sixty per cent of the apple trees were between one and twelve years of age in 1918. The estimated mortality is 1.5 per cent a year. The production in Virginia may be expected to double in the decade from 1920 to 1930, unless one of the unlooked for catastrophes should come.

People plant apple trees when prices of apples are high. They pay no attention to the number of trees that are being planted. When many rush into the planting business, the careful men will probably go slowly, and when people are abandoning planting, they will increase the acreage, if anything. In the past the waves of over-production and under-production have ranged from about twenty to twenty-five years, so that few men have a chance to make more than two decisions in a lifetime in regard to apples,—that is, whether to plant or not; whereas, with hogs, there is usually an advance in price for two or three years and then the price drops for two or three years. With horses, the wave is about eight to ten years and one is able to get in and out in a much shorter time than one can with apples.

Age of most profitable production. In New York, the trees probably enter into their most profitable bearing period at from twenty-five to fifty years of age, whereas in the Ozark Region they are probably past their zenith at thirty. On irrigated ranches in the Western states, we have not yet sufficient indication as to the actual life of the trees to draw any conclusions.

CHAPTER II

CLIMATE

A favorably located site is essential for success in fruit growing. Climate and soil are two limiting factors in fruit growing; and while there are large areas of fruit soils, there are but limited areas possessing a fruit climate. Climate can seldom be modified, generally it is uncontrollable.

Bloom the critical period. May is usually the critical month for apples in the northern apple regions, and April further south. This is the season of bloom. At the time there is possibility of frost, rain and a marked variation in the daily temperature, as warm days and cold nights. A hot day followed by a cold night during bloom is injurious to the blossoms; it lowers their vitality and stunts their growth. It may inhibit the growth of the pollen tube to the ovary, even if the pollen has reached the stigma. A climate with but slight difference in temperature between day and night is most favorable; such is found in the proximity of large bodies of water.

Bodies of water modify climate. Just how large a factor water is in modifying this daily variation is seen at Block Island and Nantucket, where the average daily difference is but 11 degrees; along the Atlantic Coast it is 16 degrees. It increases rapidly as one moves west from the coast line, but falls again as one approaches the Great Lakes.

Location of important apple regions. The variation between the day and night temperatures in New Jersey, Delaware, the eastern part of Maryland and Virginia is about the same as that along the shores of Lake Ontario. In both instances, we find apple regions of the highest rank. The Annapolis Valley in Nova Scotia, alongside the Bay of Fundy, the eastern shore of Lake Michigan and the Pacific Coast states are all fruit regions because of their climate.

What is a favorable climate? As a general rule wherever the daily range of temperature is 20 degrees or less we have favorable conditions so far as this factor is concerned. A small body of water or local conditions may materially affect the farm. After all, the important fact is the relation of climate and soil to the farm itself.

Rain, the chief factor in determining yield. Rain during the period of bloom is probably the most important climatic factor in controlling the yield of fruit in the Eastern and Central states. We need rain, but sometimes the fruitgrower feels he would like to arrange for its arrival; this the western man frequently is able to do with irrigation, and in this he is favored more than many realize. In the Northeastern states the regions of lowest rainfall in May are northern Vermont, the Champlain Valley, the central Lake region of New York and the south shore of Lake Ontario; here the average May rainfall is under 3 inches. Most of Pennsylvania, northern New Jersey and parts of Virginia and West Virginia have the highest.

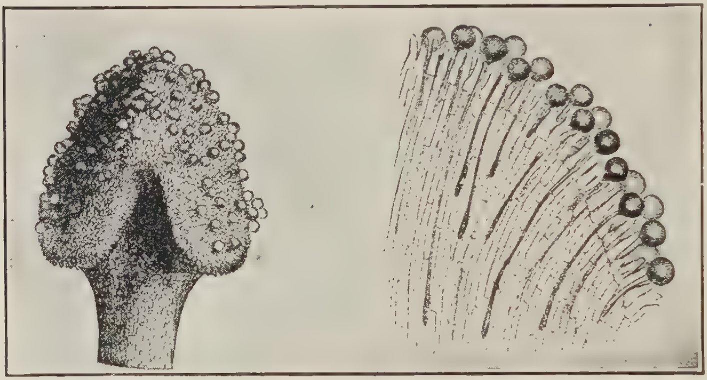


Fig. 3. Stigma of Thorn Apple (Datura) with Pollen (magnified)

Part of Stigma of Thorn Apple showing pollen tubes making their way toward the ovary. (Bergen, *Elements of Botany*)

Pollination determines the yield. The crop of apples is dependent upon the pollen, the male fertilizing agent of the apple reaching the ovary of the bloom and fertilizing it. On a bright, clear day the pollen grains burst into activity. They are carried by bees and other insects; they may be blown by the wind or merely fall upon the sticky substance on the surface of the stigmas, which provide the contact between the ovary and the outside world. Upon arrival on the stigmas, if conditions are favorable, the pollen grain begins to grow; it develops a stalk or tube in a short time,—from a few hours to a few days,—and finds and reaches the embryo in the ovary. This accomplished, the fertilizing material is passed from the pollen grain to the embryo and the work of the pollen grain is done, It remains there, a dried up and useless organ. Its life has been transferred to another. The life endures, the body in which it moved becomes a shell. Cut an apple crosswise and you will find five cavities; and in each, one, two or perhaps more seeds. One pollen grain was used to fertilize each seed. If the embryos are not fertilized the apples form but later may fall off, or if they persist the apple may not reach normal size. The tree's object in producing apples is to reproduce itself by forming seeds.

The June drop. If an apple is not fertilized, seeds are not formed. The fruit being useless, usually falls off, and we talk of the June drop in the orchard; then the useless apples are got rid of. Apples may drop because of attacks of fungi or insects, or of other causes not known. Weather favors or retards the development of insects and diseases.

Why and when we thin. The drain on the tree is not the growing of the skin and flesh of the fruit; it is the formation of the seeds. Therefore, if one would thin the fruit, it is better to do so before much energy has been expended in the formation of seed. In the apple, this is usually after the June drop, during July. A second thinning follows in August if necessary.

How rain prevents pollination. When rain continues for two or three days during the period of pollination, as it sometimes does, the pollen often is prevented from being distributed from the "anthers" or the pollen sacs so that the time for pollination may have passed before it has a chance to do its work. Rain may wash the secretion from the surfaces of the stigmas or so dilute it that the pollen grains fail to germinate when they alight on them; again a cold rain may so chill the pollen grains that they fail to grow. Some state that an excessive amount of moisture may soak and cause them to swell and burst. Rain also may keep bees and other insects from visiting the flowers to aid in the transfer of the pollen.

Success depends upon the harmonious working of a multitude of trifles. Until we begin to understand, how little do we realize what the small things in life mean! The trifles make life. The fruitgrower's success is dependent upon the harmonious working together of a multitude of trifles. Professor Ward said: "Life is the continuity of molecular accord." The actions of this bee, this pollen grain and this small embryo must be in unison, and then the small embryo must be able to adjust itself and act in absolute accord with all kinds of changing and variable conditions right up to the end, until its seeds are ripe.

The benefit of water in frost control. "Frost tonight" says the weather bureau, and the fruitgrower looks around anxiously. If he is in California, he probably looks over the heater pots which are ready in the orchard, 70 to 200 to the acre; and if the night is calm he can hold the temperature of his orchard from 4 to 10° F. higher than that prevailing in the area outside. It may save the crop; if the wind blows it may fail. An acre of water surface 1 foot deep will give off more heat every hour, with a fall in its temperature of 1° F. per hour, than will the 70 heater pots, but you cannot direct all of this heat to the orchard alongside. However, it illustrates the value to an orchard of being close to a body of water.

Select a site with a lake on the north or west. Small lakes, especially when situated on the north or west of the orchard, are of great value. On a frosty night the wind is usually from the north or west and in blowing over the surface of the water it is tempered. The water is of twofold benefit: It not only warms the night air, but it tends to cool the air in the day time and thus retards bloom, often delaying it, that the critical period may be passed in safety.

Buffalo, N. Y., has an annual range of variation in temperature of 94 degrees, the same as New York City; Chicago has 108 degrees, Duluth 120 degrees. Buffalo can grow apples; it does not get so cold or so hot as Duluth. The prevailing west winds travel over the lakes before they reach Buffalo, whereas those westerly winds reaching Duluth have traveled over land that is hot in summer and frozen in winter. The beneficent action of these lakes in moderating the climate makes the counties along the lakes in western New York veritable garden spots, the home of the Baldwin apple and the peach, both equally tender, and the shores of Lake Erie a vineyard. The climate of Ohio is modified, also that of Michigan. The Baldwin apple cannot be grown west of this point, except in the Pacific states, since it cannot survive the violent changes in temperature. Denver has an average of 25 days a year when the thermometer reads 90 degrees or more. New Orleans has 43 such days, St. Louis 28, San Francisco 2, while Buffalo has less than one in two years due to the westerly wind off the lakes.

Crops lost from rain more often than by frost. There is always a risk of losing a crop by frost. Even Niagara County, New York, close as it is to Lake Ontario, has lost fruit crops four years in twenty-five, and has had them injured in several other years. Delaware, located between the Atlantic Ocean and the Chesapeake Bay, has lost its peach crop on different occasions. The chance of loss by frost is always present. The public have come to realize this to a degree, but they fail to grasp that the loss of a crop by excessive rain occurs more frequently.

The north and south slope. A hillside sloping to the south is warmer and is usually less subject to frost attack, but fruit-growers often prefer the northern slope, owing to the fact that the opening of the bloom is usually sufficiently late as to compensate for the greater susceptibility to frost.

Air drainage. Hillsides are preferred to valley floors. Frost pockets are undesirable. Frosts will occur on the floor of a valley when they do not occur on a hillside. An orchard should not be planted in a pocket where the cold air assembles at night. One can determine these by hanging self-recording thermometers on poles in various parts of the farm. Even by walking over the farm at night the warm air will be encountered, moving upward onto the hillside, while the cold air, being heavier, passes down into the valley. This is frequently referred to by orchardists as air drainage.

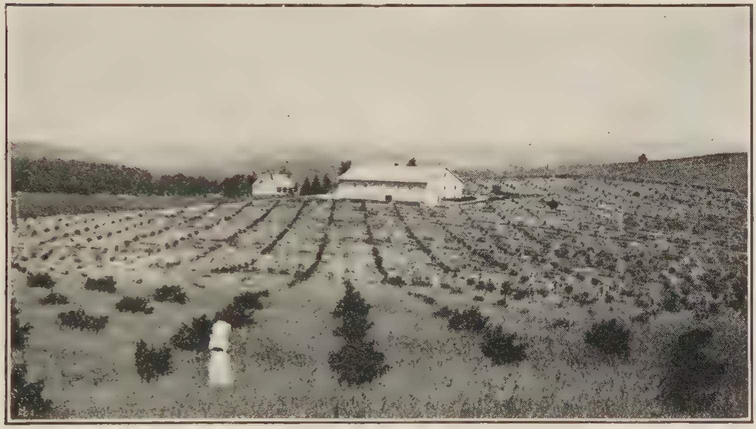


FIG. 4. A fine site for an orchard. Good air drainage.
Courtesy Dr. R. B. Reitz, Brookville, Pa.

One of the most striking examples of the value of avoiding pockets is reported by Professor Macoun from British Columbia. In the Salmon Arm district fully 50 per cent of the apple trees were killed in 1916; those on the hillside, not 50 feet away and of the same variety, were free from injury. At the time of bloom in Charlottetown, Prince Edward Island, there was a difference of 9° F. between one point and another, 33 feet below the highest, on two nights, and 12° F. on another night. These differences in temperature are sufficient to explain why crops of apples are much more uncertain in a frost pocket than on a hillside.

Undesirable features. Avoid locations where there is a wide range of variation between the day and night temperatures. Avoid regions subject to high wind. Avoid low regions distant from large bodies of water. Avoid valley floors and cold air pockets where the cold air cannot drain away.

Desirable features. Locate in regions where there is little variation in the daily and nocturnal temperatures; near a body of water, situated preferably on the north or west side of the orchard; on an elevation where good air drainage is possible. And to emphasize the importance of climate, it is stated that considering all farm crops as a unit the total damage suffered may be stated as follows: 81.8 per cent due to weather, 4.8 per cent due to plant diseases, 7.9 per cent due to insect pests, 1 per cent due to animal pests, 1 per cent due to defective seed and 3.5 per cent not known.

Weather. The mean or average temperature is of relatively little value. One needs to know the periodicity of temperatures, both high and low for his immediate location. Frequently, the cold winters appear in groups of three or four. One needs to know the frequency with which, as well as the time at which, critical temperatures occur. If they occur too often, the prospect of success in fruit growing may be remote. It is important to note that the period of duration of very low or very high temperatures needs not be long in order to destroy the prospect of a fruit crop. The weather has a marked influence on crop movement and the demand for fruits. The weather may make or destroy the market. For instance, peaches, watermelons and cantaloupes, are wanted in hot weather. Apples sell better in cold or cool weather. Very hot weather may destroy fruit on the trees, cause heavy losses in transit and at destination and reduce consumption. Severe cold weather may prevent the movement of a perishable commodity. Mild weather, by permitting peddlers, pushcart men and others to operate, may enable a crop to be marketed which could not be sold otherwise.

Taking the largest cities in the United States, St. Louis has had the highest maximum temperatures, although New Orleans has the highest mean or average temperature. In 1901, a hot July was recorded. At Columbia, Mo., from the latter part of June to the end of July, for 34 consecutive days the thermometer registered over 100 degrees every day and on July 12, 111 degrees. St. Louis had 107 degrees on July 24 and on 38 days between June 19 and August 3, a maximum temperature of 90 degrees or more was recorded with over 100 degrees on 15 days. The year 1918 shows another hot wave in July and August, which swept across the country for about ten days. Chicago and the cities on the Lakes got a respite because a wind came up from the lakes for two days in the middle of the hot wave causing a drop in temperature from 103 degrees to 71 degrees.

Rainfall in the United States. East of the Rockies the rainfall increases as one goes east. It also increases as one goes from north to south. On the western side of the Rockies the highest rainfall is seen in Oregon and it falls off as one proceeds south. The actual average rainfall in certain cities is as follows:

City	Inches
Moorhead, Minn.	24
Marquette, Mich.	32
Northfield, Vt.	33
Omaha, Nebr.	30
Chicago, Ill.	33
New York City	44
Galveston, Texas	46
New Orleans, La.	57
Jacksonville, Fla.	52

Distribution of rainfall. The time of year at which the rains occur has an important influence upon the crops that can be grown. This fact is worthy of note in locating a fruit industry. To proceed, secure the average rainfall for April, May and June and compare with that of August, September and October. A copious rainfall in the first period is good for the crops, heavy rainfall in the later period is bad for the soil.

Winds and rainfall. Most of the tornadoes occur in those regions where the early summer rainfalls are excessive. They usually occur in spring and early summer. Hurricanes occur where the rainfall is excessive in the late summer and fall. Where there is not more than 1 or 2 inches difference either way between these periods, there is little damage from wind. Winds are frequently very destructive to trees and fruit. They may be sufficiently frequent and violent to destroy fruit trees or prevent their successful production.

Time of rainfall. The late summer rains commonly come in the form of showers in the day time, while early summer rain is more likely to fall gently at night. This is a very important factor in the labor problem.

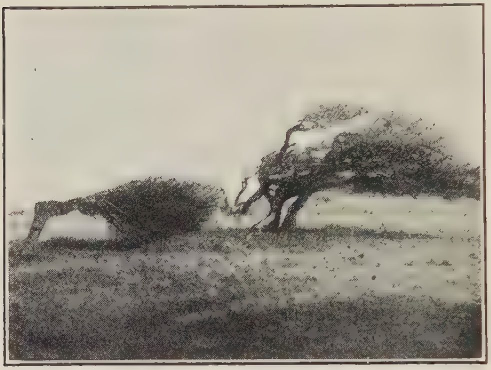


FIG. 5. The effect of wind. Left, Prunus spinosa; right, Hawthorn (Cratægus oxyacantha). Photo by Prof. Dr. Warming, taken in Denmark

Rainfall and soils. The most fertile soils are in those regions where there is more rain in early summer and less during other seasons.

Correlation of crops and rainfall. Alfalfa, wheat, figs and upland cotton are not raised extensively where the late summer rainfall exceeds that of the early summer by more than 3 inches, while sugarcane, pineapples, grapefruit and sea-island cotton thrive where late summer rains prevail. Of course, by means of irrigation, we can overcome lack of rainfall and do so with fruit crops.

Sunshine. The average amount of sunshine in the United States is about 50 per cent. In the Southwestern desert regions it is 70 per cent; on the North Pacific Coast (Oregon and Washington) 40 per cent; near the Great Lakes, as in Western New York, in the winter months it is but 30 per cent. In Nova Scotia we see a minimum average of three to four hours a day in certain years even in the summer months of June, July and August. There is considerable variation due to local conditions, all of which have a marked influence on crops, methods and practices.

The so-called bio-climatic law. General observation has shown that seed time and harvest, the dates of arrival of certain insects and the time of application of remedies against them and diseases and other farm operations occur in the different parts of this and other countries in more or less sequence. The date of harvest of the wheat crop is later in the year as we proceed from south to north, or as we move from the valley onto the mountain side. Other things being equal, this variation is at the rate of four days for each degree of latitude, five degrees of longitude and 400 feet of altitude. Isophanal maps of the United States have been constructed on this basis.

CHAPTER III

SOIL

The soil is that which we till. The French gardener takes it with him when he moves. He buys or rents a piece of the earth's surface and hauls his precious soil and lays it down thereon. It is his, his most priceless possession. It is now doubly dear. It was handed down from his sire and grandsire and is a family treasure, and France is great because France knows the value of the soil. William of Normandy grasped the soil of England as he fell and brought cheer to his Barons as he picked up a handful and exclaimed that he had England in his grasp. France and the French have long known the art of managing the soil, and the production secured is not only due to the skill of the individuals, but to the continuity of purpose. The soil of France is so sacred that it is something which must be passed from generation to generation with its productivity enhanced and not diminished. The French love the soil of France and that is why it responds.

The soil returns an ample reward to him who truly tends it. Here as in France, the soil is what we till; if we till little we get little. To him that loveth much, much is given. The soil never grows old in the hands of those who know it, who feel that it is a living, active, responsive being. To those who joy in their work this old earth laughs with them, and great is their reward for they become actual partners of God in his work. They make the soil. L. H. Bailey said: "The soil is the cemetery of the ages and the resurrection of all life."

In humid regions. In the humid regions the upper or surface layer to a depth of 3 to 10 inches or more may be recognized as differing somewhat in color, texture and various other characters from the layer below it. The surface layer is known as the soil, that below it as the subsoil. A soil 10 inches or more deep is spoken of as deep, one 2 or 3 inches in depth is said to be shallow. The subsoil, if but a couple of feet to rock which is impervious, might be said to be shallow, while if 5 or 6 feet or more it might be said to be deep. The depth of soil and subsoil often determines the amount of water available for the crop. Unless the shallow soil is so situated that it benefits from seepage it may be deficient in moisture in a dry season and as a consequence we have a crop failure owing to drought.

In arid regions there is frequently no marked difference between the surface foot and the third or fourth foot. They are alike; it is all soil and it is possible to grade for irrigation purposes without regard to the depth of excavation. Frequently soil secured at a depth of 8 feet from the surface may be spread on the surface and used at once as soil for crop production. This would be impossible in the humid regions.

Depth of the soil. One of the first considerations in the soil for an orchard is its depth. Long-lived trees are not found on shallow soils; this is true of apples, pears, olives or pecans. Many orchards are planted in places where the trees will grow for five, ten, twenty or even thirty years but not longer. Perhaps these trees are underlaid by rock or hard-pan or an excess of alkali which prohibits the roots going down to a proper depth. In some instances the subsoil is too wet, perhaps due to sub-irrigation; or in the dry region after several years of irrigation the alkali level may rise and destroy the roots so that not only is climate important, but for long-lived trees there must be a sufficient depth of soil to ensure a good root hold, a good supply of plant food and a sufficient amount of moisture.

Depth of roots in the soil. So far we have insufficient knowledge regarding the roots of trees to answer many important questions. We know that, generally speaking, the roots of trees penetrate to a greater depth in arid than in humid regions. Grape roots have been found 22 feet below the surface in arid regions and 15 to 20 feet is common, while in humid regions 5 feet would be deep.

Roots are shallow in humid regions. In humid regions the roots spread out in the surface layer. In apples and many other fruits, the spread of the roots is at least three and often four times the spread of the tops. In some soils, as poor sands, they may be spread over a much greater area,—and these roots are located near the surface.

The location of the roots determines farm practice. This distribution of roots is important to remember when applying fertilizers. In arid regions the roots cover less area but penetrate much deeper, with the result that trees in California, for instance, may without irrigation, thrive and produce their fruit during a period of four to six months of practically absolute cessation of rainfall, whereas east of the Mississippi a similar cessation for as many weeks would ruin the crop and might kill the trees. There is great need for considering the factor of depth of soil and its character when locating an orchard, both east and west a deep soil is needed for the same reasons,—as a reservoir for moisture and because such soils are more economically worked. A faulty substrata in the arid regions is as serious a condition as a shallow soil in the east. The depth to which trees will root varies also with the seedling used for the stock. Tall growing trees are not necessarily deep rooted nor are dwarf trees necessarily shallow rooted.

Water in soil. Under ordinary conditions and within limits, which vary for the different soils and crops, the yield is almost directly proportional to the water supply during the period of most active growth. In most humid regions crops could be doubled if the soil moisture could be maintained at the optimum. There is every reason to believe that the amount of water needed to produce a crop in one region is not necessarily a guide as to the requirements for the same crop in another, nor for the same crop on the same land under different management. Plants accustomed to the dry air and scanty moisture conditions of California will not wilt or suffer under extremely rigorous conditions—conditions which the same plant in a humid region would not be expected to endure.

The free moisture of the soil. The total amount of moisture held in a soil is no guide as to the amount available, since in every soil a certain amount of moisture is so firmly held by the soil that no plant can take all of it away. In California with apples, 8.3 per cent of moisture in a loam soil was adequate to keep the trees in excellent condition, while on a clay soil holding 12.3 per cent of moisture the condition of the trees was very poor. It is the amount of free moisture in excess of what is held by hygroscopic absorption, that determines the welfare of the plant. The hygroscopic moisture may be said to be that which is held by the soil when it is air dry.

Amounts of water used. The main functions of soil water are to transport the food from the soil to the leaves and, when elaborated, back to the growing parts, and to keep the plant cool. The evaporation of the water through the leaves is in part for this latter purpose. When the plant gets too hot because of lack of water it wilts, and if this condition continues the leaves may fall off and the fruit may follow. Also if the temperature of the soil and air goes too low the plant wilts, and for the same reason the movement of the water is disarranged. This is often seen in semi-tropical plants even at temperatures much above freezing. The lesson is that the plant can function only within a narrow range of temperature.

It is estimated that for citrus trees about 500 pounds of water are required for each pound of dry matter elaborated by the tree. At Riverside, California, a fifteen-year-old orange tree produced 40 pounds of dry leaves, to manufacture which demanded the use of 20,000 pounds of water per year, or about 1,000 tons per acre for 100 trees or about 9 acre inches of rainfall out of the 35 inches usually available. Most of this rainfall is lost either by running off the soil or soaking through it and escaping into the streams or by evaporation, so that at Riverside, irrigation is necessary to grow a citrus crop. Unlike an apple tree in New York, which is active seven months of the year, the orange stays active the entire year.

Concentration of the soil solution. Plants take up their food in liquid form from the soil solution. The soil solution varies in composition with the soil and conditions. Plants appear to exercise a selective power as to what they will use. The benefits derived from tillage, by some are held to be due to an increase in the concentration of the soil solution, the claim being that tillage admits air to the soil and causes an increase in the materials held in the soil moisture, and that because of this increase a lesser amount of water is required to make the same amount of growth, with the result that the water supply goes further. Some question whether there is any direct saving in moisture from tillage as has been commonly taught, but hold that the saving is due to the plant using less during the early growing season so that the supply lasts longer. Whatever is the real explanation, and it would be desirable to know what is going on in the soil, the fact remains that tillage frequently makes plants grow better than if not tilled.

Soil bacteria. It is now recognized that the soil is the home of multitudes of bacteria and small organisms. It is a place of ceaseless activity, through frost and summer heat this never ceases. Some of these organisms are beneficial, others injurious. In order to secure good crop yields it is essential that the desirable organisms be furnished not only proper food, but that the soil be maintained in a suitable and sanitary condition for them, otherwise they cannot live and work.

The soil is much more than a medium in which the tree is held by means of its roots. Through its roots it comes in contact with the soil organisms and the products of their activity, and it is by the utilization of the work of these insignificant agents that the tree grows. Not only must the soil be made sanitary and a suitable home for the roots of the tree, but for the desirable organisms also and one of the great purposes of soil-amelioration such as drainage, tillage, fertilization, etc., is to furnish these desirable conditions to soils which are deficient therein, or to retain them in soils where they exist.

Symbiosis. In the case of many trees and shrubs, among them pines, firs, beech, etc., the members of the heath family as the huckleberry, blueberry and cranberry, we find a close relationship between the plant and certain fungi, which live on their roots. The host plants cannot live without them. The fungi prepare some of the organic and inorganic substances in the soil, elaborating them into suitable forms for assimilation by the host. In these cases fungi are essential to the life of our food plants, but in the case of root-rots we find fungi detrimental to our food plants.

Injurious substrata in arid regions. In many cases in California serious loss has followed from planting orchards on soils underlaid by an impervious substrata as hard-pan or marl, also on extremely porous subsoils as coarse sand or gravel which do not hold water well. On such, the trees grow for two or three years, then turn yellow and languish and die owing to lack of water. The substrata should be inspected to a depth of at least 7 feet.

Hard-pan or a shallow impervious strata may be broken by the aid of dynamite, but a porous substrata cannot be remedied. Where marl is encountered in such excessive quantities that it causes yellowing of the leaves, due to the excess of lime in the soil, loss may be avoided by planting only such fruits as are adapted to the conditions as Crab apples, American plums in the east, and Texas grapes and Chicasaw plums in the west.

Tolerance of alkali by fruit trees. The three common salts which go under the name alkali are: Glaubers salts or sodium sulphate,—white alkali; Salsoda or sodium carbonate,—black alkali; and common salt or chloride. These may be transported from the subsoil to the surface by evaporation of the soil water and this is often seen in certain irrigated regions. Alkali is less destructive on sandy soils than on those of closer texture. Plants vary in their ability to tolerate alkali, and there is considerable variation among varieties.

The European grape is quite resistant to alkali, but since, in California, it usually roots at 15 to 20 feet deep, over-irrigation, which might move the alkali into the root zone must be avoided. The alkali corrodes the roots and destroys the vines before it shows on the surface and much money has been lost thereby. Citrus fruit trees are quite sensitive to common salt, and when young the trees are more easily hurt than later. The olive has for a long time been inured to alkali and the same is true of the date palm. The amount of alkali that selected varieties will tolerate is still a matter of research. The almond and fig appear close together in the list, followed by the orange, apple and pear, which have a decided advantage over the peach, apricot and prune. The quince ranks about with the fig. The Persian Walnut while fairly tolerant of white alkali cannot resist the black alkali at all. The Myrobalan plum is a native of a region where alkali abounds, Asia Minor, and is suggested for use as a stock as far as possible for stone fruits, except for the almond which is relatively resistant on its own root.

Reclamation of alkali land. When land is already planted to fruit and the investment is heavy it may be necessary to undertake to save the trees. Thus far the means of reclamation advised is to underdrain the land and then flood it with an ample supply of water to wash out the alkali. Black alkali is often neutralized by the application of land plaster or gypsum, the amount necessary varying with the amount of alkali present. Gypsum is of no value for removing white alkali or common salt. The only way to remove these is by washing them out.

CHAPTER IV

TILLAGE

Estimates indicate that about 10 to 16 acre-inches of water are necessary for the production of most of our crops. This amount must be available for the use of the crop during the period of most active growth. With 31 inches of rainfall at Rothamsted, England, which is about the average of the United States, and on a clay loam soil, half of the rainfall runs off the land, a little less than half enters the soil to a depth of 20 inches and 45 per cent reaches to a depth of 60 inches or more. Since but half of the rain falls during the period of active crop growth and but half of this is available for the use of the plants, it follows that some must be stored in the soil or a reduced yield of crop will result.

Ways in which water is lost. Water is lost from soils not only by "run off," but by seepage and evaporation. In dry regions the amount lost in these ways is much greater than in the more humid parts of the world. We have but to watch a stream in flood carrying soil away to the sea by the thousands of tons to realize that the "run off" is frequently an important destructive agent on our farms and that this factor alone often determines whether a hillside orchard can be cultivated or must be kept in sod to prevent the washing away of the soil. Tile drains reduce the wash by furnishing channels for the water below ground rather than on the surface, and the soil benefits by the passage of the water through it, on its way to the drain. As a rule the amount of soil moisture most favorable for the production of crops is about half of the maximum that the soil can hold. One of the prime objects in tillage is to maintain the ideal condition by reducing the losses by evaporation and increasing the storage capacity of the soil. Also, tillage destroys weeds so that the water, food and sunshine are left available for the crop.

Irrigation is used as an adjunct to tillage to furnish water at the time the plant is in need thereof. The greatest benefits are secured from these

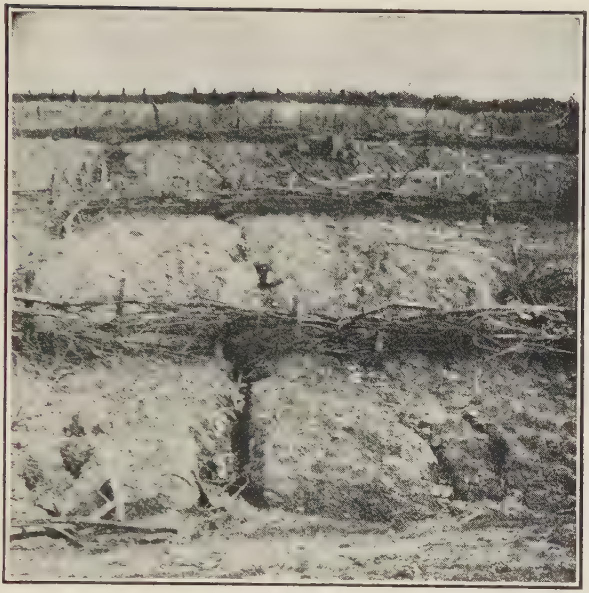


FIG. 6. One reason for leaving hillsides in grass. This land was planted to peaches but soil erosion was too serious a problem. Brush dams are being used to hold the soil preparatory to planting forest trees. (U.S.D.A.)

operations when the moisture content is held at the optimum. An excess of moisture is a detriment.

Tillage rearranges soil particles. Tillage puts the soil in good mechanical condition. Plowing causes a rearrangement of the soil particles, so that they occupy a greater volume than before. In other words, there is an increase in the air space in the soil, which improves it as a home for the beneficial bacteria and other organisms. Hence, we get an increased output from the plant-food-factory workers and the crop shows it. Tillage pulverizes the soil particles so that the physical condition of the soil is changed, which affects its water holding power. By increasing the concentration of the soil solution the water supply is conserved.

Common practice in tillage. In actual practice apple orchards are cultivated thoroughly during the period of wood growth, say up to June or July, both to encourage growth and to save water for use later in the season. A cover crop is seeded, the function of which may be at least twofold: one to furnish organic matter to the soil and aid in maintaining good tilth, and the other that in case of excessive moisture later in the season, due to abundant rainfall, there will be a crop on the land to use it, thus saving the trees from being forced into an excessive and late wood growth which might be destroyed in the winter.

Effect of rain and sun on the dust mulch. A beating rain is apt to compact and puddle the surface of a finely pulverized soil. The soil particles lose their granular form. This is especially true if the soil is clay. If the sun comes out it may bake and form a crust, a condition intolerable if we would grow plants thereon; hence the advice is given to cultivate as soon as possible after a rain to restore tilth. Nature's law is one of compensations. Having broken the surface soil with a plow, one must continue to use it if he would be rewarded.

How nature tills. In the woods or prairies of the humid region nature maintains soil tilth by filling the surface few inches with a network of living and decaying roots and covering the surface with living and fallen foliage. Nature cultivates the soil by forcing a root instead of a plow through it and maintains a mulch of leaves above; in addition she increases the store of humus therein instead of diminishing it as we often do when we plow and grow no cover crop. If we can use nature's way of maintaining the soil in good tilth less labor will be involved than when mechanical tools are drawn by expensive motors. Whether to leave the orchard in sod or cultivate must be settled by the individual after careful study of the crop requirement and of the local conditions.

Arid Regions. In the arid region no such conditions prevail as are seen in humid regions. The grass or herbage, when there is any, grows in tufts or bunches. It does not form a carpet and a different set of conditions demand different treatment in order to secure results. Because intensive tillage has given satisfactory results under these conditions, it does not follow that it is equally economical to give the same treatment to soil located in humid regions. Even in the arid regions when tillage in the orchard is carried to excess, disaster follows. Rosette and other physiological troubles attack the orchard and the remedy is to grow crops—legumes in the orchard, alfalfa being a favorite. To operate the soil successfully one needs to use all natural forces, harnessing and directing them towards a profitable end. It may not appear spectacular, but it will be efficient.

The dust mulch. A layer of loose, dry soil prevents evaporation. On a cultivated orchard it is regarded as economy to retain a dust mulch throughout at least part of the growing season. How deep should it be? In humid regions in the East and Central states where the roots of the trees are near the surface and where rain comes at intervals of 7 to 20 days a depth of 3 inches is probably adequate. For corn this might be too deep and it is probably a little too deep for currants, gooseberries and raspberries in the East. A 2-inch mulch is more common than 3 inches. The dust mulch should be maintained by going over the soil every week or ten days, especially after rains. A shower is often a detriment; it may merely injure the mulch and necessitate more work.

In arid regions where the feeding roots are located deep in the soil and where irrigation is practiced at long intervals or not at all, and where no water may enter the soil for a period of two to six months, a depth of 6 inches is essential and on light sandy soils a 7- or 8-inch dust mulch is better.

Tillage and a dust mulch. The year 1898 was very dry in California. It furnished an excellent opportunity to test the value of a dust mulch. Two orchards of apricots at Niles, California were studied: one was not cultivated, the other cultivated to an extra depth in view of the dry season. The cultivated trees made 3 feet of wood growth, those not cultivated but 3 inches. The fruit on the cultivated trees was of good normal size, that on the uncultivated was stunted and unsaleable. The following year the uncultivated trees were cultivated and grew as vigorously as those which received tillage the year previous. The trees were capable in both instances. What caused the difference? A careful determination of the moisture in the soil was made in July and is shown in the table on page 40.

Time to plow. Many cultivated orchards are plowed at least once a year. This is done in spring, although in the Northeastern states, owing to the need for speeding up the spring work, the custom has grown of plowing under the cover crop late in the fall. The furrows are turned to the trees, leaving a dead furrow between the tree rows; and then plowing away from the trees with a gang plow the next spring to make the

MOISTURE IN CULTIVATED AND UNCULTIVATED LAND

	Cultivated		Uncultivated	
	Per cent	Tons per acre	Per cent	Tons per acre
First foot	6.4	128	4.3	86+
Second foot . . .	5.8	116	4.4	88
Third foot	6.4	128	3.9	78+
Fourth foot . . .	6.5	130	5.1	100
Fifth foot	6.7	134	3.4	68+
Sixth foot	6.0	120	4.5	90+
Total for 6 feet . .	6.3	756	4.2	512

A total of 244 tons more water per acre was available in the cultivated land; and this is not the whole story, for in the uncultivated area the 244 tons less had not only been lost by evaporation from the surface by July 2, but a large amount of the water left in the soil was lost in the same way. The mulch reduced soil evaporation to a minimum, and the water which left the soil had to go through the trees, probably carrying plant food with it; at least the trees under cultivation grew and prospered. In the uncultivated area the inference is that the water was lost by evaporation from the soil and did no one any good, although the tillage given may have made available more plant food and caused the soil solution to be richer thereby.

field level for the season. In all cases the plowing is not very deep, 4 to 6 inches generally; or less would be better. Where the ground freezes in the winter, and on farms where the amount of spring work is considerable, the labor problem determines the policy. Whether it is better to plow the cover crop under or leave it standing is often a secondary consideration. In Florida, with oranges it has been determined that it is often detrimental to leave the cover crop on the land all winter.

No plowing for peaches and small fruits. With peaches and small fruits many growers feel that it is frequently better to work up the land with harrows and orchard cultivators than to plow at all, trusting to the roots of the cover crop to cultivate the soil. This is quite feasible and is successfully done. With figs the roots are so near the surface that merely scraping the surface may be the only tillage advisable.

Exposing tree roots is undesirable. Where it is desired to have a cover crop destroyed or put out of sight quickly the best tool is the plow, but the tearing and smashing of tree roots by deep plowing is not desirable any time, neither is the deep tillage of northern orchards during June or later. The destruction of the mass of fibrous roots then present and especially in the surface soil in the humid regions is certainly anything but desirable. These fibrous roots have been developed to gather food to ripen the fruit crop and form buds for the succeeding year's crop; to destroy them is not good sense. In arid regions the roots may not be present in the surface few inches.

Irrigation is of importance to those who grow fruits where the rainfall is less than 15 inches and is sometimes used in regions having high rainfall. It is used as a supplement to tillage. It is more often practiced with large trees which have reached bearing age than with young trees. The common systems of applying the water are by the furrow method and the basin method. The growers in these regions have discovered what the eastern growers are now discovering—that an abundant supply of moisture is one of the important factors and is practically the important factor in determining whether the trees shall be producers of large crops, be annual bearers, and be producers of fruit of large size. In fact it is safe to state that there is no other factor of the same importance as an adequate water supply. Where irrigation is practiced, the water supply is under control, provided there is an abundant supply of water. It is under these conditions that we see the apple tree at its best. The fruit tends to be more elongated and it is often of more waxy and delicate appearance. The trees have a tendency to overbear, hence the necessity for thinning; and usually they are uniform in the production of their crops. If too much water is used, however, the fruit is apt to be poorly colored and it may crack readily in shipping. It is also often of poor flavor and soft in texture. The size which the fruits will attain under irrigation is usually determined by the thinning.

CHAPTER V

THE PROBLEM OF APPLE VARIETIES

Unlike oranges, which are grown over a relatively small area, apples are found all over the United States excepting in a small area along the South Atlantic and the Gulf Coast and parts of the semi-arid and mountainous regions where it is either too dry or too cold. Apples are found well adapted to considerable areas in Canada, from Nova Scotia to Vancouver, although a severe winter like that of 1917-18 killed many of the trees in Quebec. The varieties adapted to the Canadian Northwest have yet to be developed.

Which variety of apple shall I plant? This question is of equal importance to the fruitgrower and the nurseryman. To the nurseryman, the question comes up at least three years before a tree is ready for sale. The problem with the nurseryman is: what variety is the public likely to call for three years hence? It takes three years to grow a tree even to the age of a two-year bud. With the fruitgrower the problem is: which variety shall I plant? At the close of the nineteenth century, commercial fruit growing was not on the same plane that it is today. The problems now controlled by spraying and dusting and the knowledge we possess have made the industry very much more of a business than was conceivable a few decades ago. In some regions (as the Pacific Coast states) where fruit growing was not thought of as a possibility, where even the suggestion was a matter of ridicule, commercial fruit growing is now well established. Commercial production of the peach was formerly confined to a narrow strip along the lake shores of Michigan and New Jersey, Delaware and the eastern shores of Maryland; but this fruit is now grown for local use in four-fifths of the states, and the commercial production and distribution of 30,000 carloads of fresh fruit is made possible. California leads in commercial production, growing two-fifths of all peaches.

Varieties are now needed for a large area. The problem today is not a consideration of the varieties adapted to a few restricted areas, but suitable varieties and proper methods for a very wide range of conditions. This is merely an illustration of what is true with each type of fruit, whether raspberries, blackberries, strawberries, pecans, pawpaws, peaches, plums or apples.

Commercial apple orchards are a recent institution. We usually think of New England as a long-established apple producing territory and yet, some time after the close of the Civil War in the whole state of Connecticut, there was but one commercial apple orchard—that of Josiah Merriam, which contained 1,000 trees of Baldwin. There was not another orchard of 500 trees of named varieties of apples in the whole state of Connecticut. Previous to the Civil War, our exports of apples did not average 60,000 barrels a year, now the Port of New York has moved as many in a few days. It was in 1888 that the first car of Elberta peaches was sent into New York and it was not until 1889 that the first commercial orchard of Elberta was planted in the North, so that the development of this standard variety of peach, the one which has made the commercial growing of peaches a factor, was not established until relatively recently. The same is true of such standard varieties of apples as the Baldwin.

Pomological Literature Recent. American Pomological literature is only about one hundred years old. The first book relating to fruit growing was published by Bernard McMahon just about one hundred years ago. Recently, or relatively recently, a compilation of all the varieties of apples which have been named in the United States from the years 1804 until 1904 contained 14,800 varietal names; of this vast number, 6,700 are reputed to be distinct, the remaining 8,100 being synonymous; in other words, there are on the average, two names for each distinct variety, but some varieties have thirty or forty distinct names, so that it follows that many varieties have only one; and then the question comes—which of these 14,800 names is the public likely to call for. Someone may call for one lone variety with which he has become familiar but which no nursery propagates, so that the question resolves itself to which varieties are on the nurseryman's list. It is interesting to note that these 14,800 names do not include crabs of which there were some 600 names and 375 distinct varieties, so that the field in this one fruit is enormous.

Varieties of apples listed in 1892 and later. An investigation made in 1892 by Dean Bailey of Cornell University as to the actual number of varieties in commercial use was secured by compiling those names which were found in 95 different American nurseryman's catalogue. These catalogues contained 878 distinct names of apples and crabs of which 735 were applied to apples and 40 to crabs and were believed to represent distinct varieties. In 1910, Lowther compiled the number given in one hundred catalogues of nurserymen in the United States in 32 different states and found 472 varieties of apples and 59 varieties of crabs offered, in other words, a total of 531, so that evidently there had been a decided reduction in the number of varieties of apples offered to the public.

Three varieties probably enough; ten too many. Taking the last list of varieties recommended by the American Pomological Society, we find that it contains 319 varieties of apples and 32 varieties of crabs, a total of 351, but probably ten would cover the commercial varieties desirable for any one individual to plant. In all probability three of these would be very much better than ten.

Leading varieties. Of the varieties of apples today, Baldwin is still in the lead. It is interesting to note that this variety has been fruiting since the middle of the eighteenth century. It is not a new apple by any means. It is followed in volume of yield by Ben Davis, which doubtless has been propagated at least one hundred years. The variety Jonathan was catalogued ninety years ago. The Northern Spy came into being about the year 1800. The Rhode Island Greening has been a tree of recognized worth for two hundred years. An old tree supposed to be at least two hundred years old was known to be one which had been top-worked from the parent tree. The Roxbury Russet, which originated in Massachusetts in the early part of the seventeenth century, had already made a reputation for itself, so that by 1649 grafts were taken to Connecticut. The Tompkins King appears to have been brought into New York from New Jersey as long ago as 1804. The Winesap, evidently one of the oldest and most popular apples in America and according to the lists of nurserymen, carried by more nurseries than even Baldwin, is of unknown origin, but is reported listed by Coxe in one of his historical sketches and is evidently considerably over a century old.

Benjamin Franklin had specimens of Yellow Newtown or Albemarle Pippin in London with him in 1759. The original seedling tree is alleged to have stood near a swamp in Newtown, L. I., N. Y., until about 1805 and was then probably somewhere near a century old. The original York Imperial tree was bearing fruit ninety years ago and at that time attracted the attention of the school boys in spring, who were anxious to find the apples under the snow. On account of its late-keeping qualities it soon attracted attention, and today, it is asserting itself on the New York market, where instead of selling for twenty-five cents per barrel less than Baldwin, as it did ten years ago, owing to its fine color and the fact that the men growing it are careful to pack it well, it is now quoted uniformly about twenty-five cents per barrel higher than Baldwin. Arkansas or Mammoth Black Twig originated in 1833 in Arkansas. The origin of Esopus Spitzenburg is not known, but it is over a century old. The original McIntosh apple tree was a seedling over a century ago, being found in the Canadian wilderness. In the clearing of the woods it was spared and later bore the famous apples which have but recently come into commercial use; in fact, so recent is its appearance that it was not quoted on the New York market until the last decade. It was not propagated in nurseries until 1870 and it has taken from that time to date to make it a commercial apple. Such varieties as Wealthy and Stayman are over fifty years old. The Russian apples, Alexander, Tetofsky, Oldenburg, Red Astrachan, were all imported from England about 1835 by the Massachusetts Horticultural Society. Alexander was in cultivation in England in 1758.

It takes fifty years to test an apple tree. It takes a long time for a variety to adapt and to prove itself. Although many varieties are of American origin, they have required, in the main, a century of time to develop and establish themselves in our different localities and on our markets. It is wise for a person who is undertaking planting to be sure that a variety has already proven its worth.

New varieties are a risk. There is a certain amount of risk in planting a new variety. Something a previous generation has not worked over is of too recent origin to warrant its introduction in the business of fruit growing, unless it be with such plants as small fruits and peaches, whose life is short and which readily declare their position and their adaptation. Almost every commercial apple variety is older than any of the men growing it. If the prospective planter early learns this lesson, he will be saved much trouble and expense.

The varieties of apples grown in New England are not those of New Jersey, neither are those found in Wisconsin adapted to Missouri. The best Baldwins, for instance, are found in Southern New England, New York, Southern Ontario and Southern Michigan. The reason for this variety failing when carried further south is that the summer heat is too great for it and it suffers in flavor and keeping quality. It is quite subject to Baldwin spot even in Northern Pennsylvania. It is not well adapted to the country west of Lake Michigan on account of the severity of the winters; likewise, when carried into Northern Vermont it is a failure. It cannot be grown at an elevation greater than 1,200 feet with profit in the state of Massachusetts, so that we have the area adapted to the Baldwin variety fairly well defined. In a similar way there are different sections which are peculiarly adapted to other varieties. The Wealthy apple does well over nearly all of the Baldwin belt and in a considerable portion of the states of Wisconsin, Minnesota and Northern Iowa, being able to endure their winters of minimum temperature. The Yellow Newtown thrives in the lower Hudson valley, in California, in certain sections of Virginia and in the Hood River valley in Oregon, and in these locations we find on examination that the conditions of summer temperature are practically the same. With these facts in mind Dr. J. K. Shaw, of the Massachusetts Agricultural College, has grouped the different varieties according to the isotherm to which they are adapted and these are found in the Report of the Massachusetts Agricultural Experiment Station No. 22, Pt. 1, page 194, and No. 23, Pt. 1, page 177, to which the reader is referred for a more extended discussion. Briefly stated, the more important varieties may be grouped as follows:

Apple Groups According to Their Temperature Requirements Showing the Average Monthly Mean Temperature Best Suited to Certain Varieties of Apples

52 DEGREES

Hibernal
Oldenburg

53 DEGREES

Arctic
Baxter
Bethel
Bietigheimer
Bismarck
Pewaukee
Tetofsky
Yellow Transparent

54 DEGREES

Alexander
Blue Pearmain
Fameuse
Foundling
Gideon
Jewett
Malinda
Milwaukee
Red Astrachan
St. Lawrence
Walbridge
Wolf River

55 DEGREES

Black Gilliflower
Blenheim
Cox Orange
Gravenstein
Mann
McMahon
Northwestern Greening
Ribston
Salome
Scott Winter
Shiawassee

56 DEGREES

Baldwin
Early Harvest
Golden Russet
Lowland Raspberry
McIntosh
Northern Spy
Ontario
Rhode Island Greening
Sutton
Tolman Sweet
Tompkins King
Washington Royal
Wealthy
Westfield

57 DEGREES

Boiken
Chenango
Fall Harvey
Holland Pippin
Hubbardston
Jefferis
Lady Sweet
Longfield
Melon
Monmouth
Porter
Primate
Roxbury Russet
Williams

58 DEGREES

Bailey Sweet
Early Joe
Early Sweet
Early Strawberry
Fall Pippin
Lady
Mother
Peck Pleasant
Red June
Swaar
Switzer
Twenty Ounce
Winter Banana

59 DEGREES

Benoni
Delicious
Esopus Spitzenburg
Jonathan
July
King David
Red Canada
Wagener

60 DEGREES

Cooper Market
Domine
Fallawater
McAfee
Minkler
Rambo
Rome Beauty
Smokehouse
Yellow Newtown

61 DEGREES

Maiden Blush
Ortley
Roman Stem
Smith Cider
White Pippin
Yellow Bellflower

62 DEGREES

Grimes Golden
Huntsman
Stark
York Imperial

63 DEGREES

Arkansas Black
Fanny
Stayman

64 DEGREES

Ben Davis	Lawver	Paragon	Winesap
Gano	Missouri Pippin	Willowtwig	

65 DEGREES

	Arkansas	Beach	

66 DEGREES

Buckingham	Haas (Horse)	Limbertwig	**Shockley**
Buncombe			

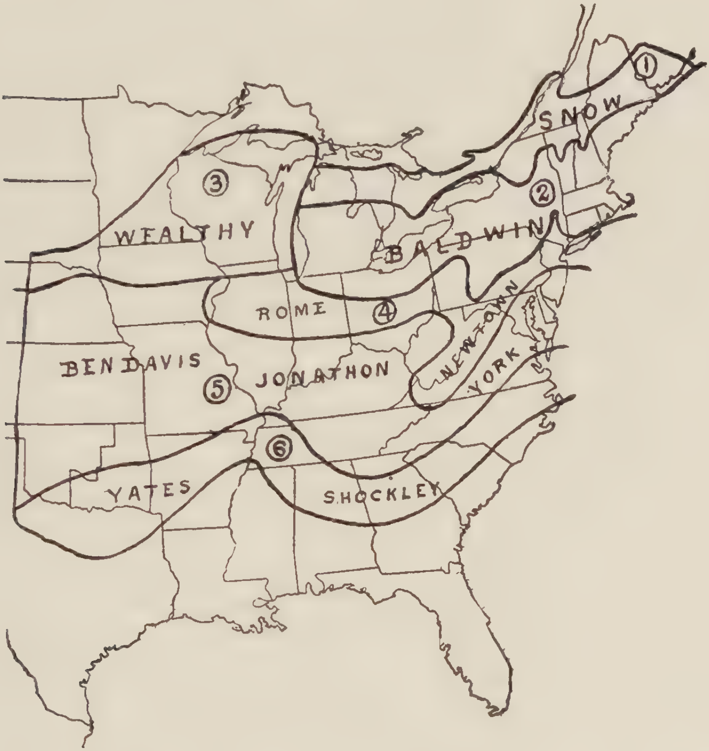


FIG. 7. Distribution of apple varieties in Eastern North America (*Diagrammatic*)

As a brief statement we may say that exclusive of Nova Scotia which falls in line closely with group 2, we find in

Group 1—Fameuse or Snow as the typical apple, with Oldenburg, Bismarck, Yellow Transparent, McIntosh, Alexander growing well. Hardy varieties.

Group 2—The Baldwin leads, with R. I. Greening, Northern Spy, Tompkins King, McIntosh etc.

Group 3—The climate is too severe for Baldwin, Wealthy may be regarded as typical with Oldenburg, Hibernal, North Western Greening, etc., desirable.

Group 4—Is the Stayman, Rome Beauty, Green Newtown belt, with York Imperial in the southern portion, etc.

Group 5—Is the largest in area and leads in the production of Ben Davis, Jonathan, York Imperial, Delicious, Winesap, Grimes Golden, etc.

Group 6—Is the southern limit of apple production with such varieties as Yates, Horse, Shockley, etc.

Climate and flavor. As a rule, apples (and it is probably true of other fruits) of the highest flavor are found when grown at the most northern or southern point at which they can fully develop and mature. Apples grown in excessive heat are poor in flavor. When grown in a climate deficient in heat the fruit is immature, lacks flavor and has high acidity, and may be astringent.

Color is dependent upon sunlight and the degree of maturity of the fruit. Apples hidden by dense foliage lack color, hence one reason for pruning. In seasons of low temperature the fruit lacks color. In seasons of excessive heat the fruit lacks color. Heat is but one factor, that the fruit must have proper maturity is equally essential. The moisture supply and vigor of the tree affect maturity. In irrigated orchards the moisture supply is withheld to ripen the wood and fruit, and the fruit colors. In orchards in sod, the moisture supply is usually less and the fruit is more highly colored than that grown in cultivated orchards alongside. Highly colored apples are more mature than those not so highly colored, and other things being equal, will not keep so well. They are nearer the point of decay. Baldwin apples somewhat deficient in color may be expected to keep in cold storage perhaps two months longer than highly colored specimens.

Bloom. The bloom on an apple is frequently a matter of climate. Some of the Russian apples as Oldenburg show bloom, so do Red Astrachan, McIntosh, etc. Apples grown in a dry climate show more bloom than those grown under humid conditions. Northern Spy grown in Colorado has more bloom than when grown in New York.

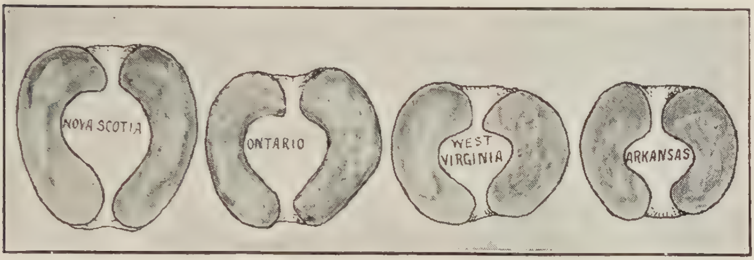
Effects of Various Conditions on Apples

Climate and soil influence the shape, size, color, flavor and other characters of the apple. When Ben Davis apples are grown in West Virginia, Tennessee, Kentucky and Arkansas they are apt to be round, sometimes even flattened. In Ontario, Indiana, Missouri, Kansas and Colorado the shape is round conic; in Nova Scotia and Prince Edward Island it is oblong conic. Specimens from these regions show more marked differences in shape than different varieties. Judges passing on fruit entered in classes open to the world need to be well informed and should know the locality represented.

Size and flavor. Ben Davis apples vary markedly in size in different localities, as well as in the quality of the flesh. Those grown in the south are more juicy and of better flavor, while those grown in the North are dry, hard and astrigent and even when apparently fully ripe these undesirable characters are not eliminated.

Color is a most important factor with an apple, especially a red one, and Ben Davis is notoriously variable. Those grown on the Pacific Coast and in Colorado had the best color. The best from the humid regions were from Pennsylvania and Indiana. In other regions, especially the northern, the apples appeared dull. The skin is generally thicker in those grown in the South and West.

Fig. 8. Typical forms of Ben Davis apples from widely separated orchards, showing the influence of climate on form



	Oblong-Conic in	Round-Conic in	Oblate to Round Sometimes flattened	
Shape:	Nova Scotia Prince Edward Island	Ontario Indiana Missouri Kansas Colorado	West Virginia Arkansas	Tennessee, Kentucky

Similar variation in shape is seen in the case of Green Newtown when grown in Tasmania, Oregon, California, New York and Virginia, as well as in Baldwin and other varieties.

In the ripening and eating qualities. Ben Davis apples secured from a large number of regions were carefully tested and it was found that the best specimens were from Colorado, Indiana, Arkansas, Oklahoma, California, Kentucky, West Virginia and Delaware, arranged in order of descending merit, after this the quality trailed off rapidly, almost all important apple-growing regions were included in the test and it was observed that variation in this character is very closely correlated with conditions of soil and climate, and generally speaking, the Ben Davis was at its best where the mean temperature of the growing season was about 64° F. North of this it is noticeable that Ben Davis ripens much better in very warm seasons, which assure it its normal heat requirement.

In a general way the problem resolves itself to this: every plant requires a certain amount of energy in order to do its work; it must get so much heat from the sun, for the sun is the source of all our energy. Ben Davis wants an average temperature of 64° F. to do its best, and every other variety has a similar requirement.

What has this to do with the commercial grower? The time is coming when with apples planted all over the country the public will begin to discriminate and ask for the best. It will not be the best Ben Davis or best Baldwin; but the public will buy any good commercial variety provided it has been produced at its best; but it is necessary for the successful grower to find out which one he can best produce. We need to do but one thing better than any one else in order to be a success. To grow the best Jonathan, Grimes Golden, Stayman, McIntosh, Delicious, or one of many more varieties will probably bring in higher returns than to grow the best Baldwin, although Baldwin is the apple which leads all others in quantity with Ben Davis a close rival. Whatever variety we plant we should be able to grow it to perfection in order to secure the full reward.

Important as the factor of summer temperature is, one must not lose sight of the fact that it is but one. The temperature during the seven growing months may be adequate to mature a given variety of apple, but the winter temperatures may be so low that the variety refuses to live. For example, following the isotherm 56 degrees westward, we cannot carry the Baldwin with us further than Michigan. It will not live through the winter or grow with the rainfall of South Dakota. Michigan is its western boundary. It is the sum of all factors that determines whether a variety should be planted or not. All must be favorable to develop a variety to its highest degree of perfection.

Apple Varieties for Certain Localities and Soil Types

It is recognized in the Southern states that a variety of cotton adapted to low, rich land will not thrive as well on upland as cotton developed for such locations. The contrary is also true. Likewise, in the same township some soils produce a better type of Baldwin apple than others; further south the same is true of Stayman, Winesap and Delicious.

Different varieties of apples have different soil requirements. H. J. Wilder of the United States Department of Agriculture has studied the conditions which give the best results for the different varieties of apples in the eastern United States among which are the following:

Baldwin. The ideal Baldwin soil is a fine sandy loam or light mellow loam, underlain by a light clay loam or heavy silt loam. The surface soil should be of a dark brown color and contain considerable organic matter.

Rhode Island Greening. This apple thrives best on a heavier soil than that required for the Baldwin; it desires a heavy silty loam or light silty clay loam, underlain by a clay loam. The land should be moderately rich in organic matter, more so than for the Baldwin, and the land should be well supplied with moisture. The Rhode Island Greening will grow on land which is a little too wet for the Baldwin.

Hubbardston. Hubbardston requires a light sandy soil or sandy loam somewhat too light for the Baldwin, but this soil must be rich enough so that the tree will thrive, probably a fine sandy loam a foot deep with a sandy loam subsoil. A similar soil may be used for Sutton.

Northern Spy. This apple requires a medium loam underlain by a heavy loam or light clay loam, a soil a little lighter than required by the Rhode Island Greening. On too heavy a soil the Northern Spy tree makes too much wood growth, the fruit fails to color well, the skin becomes kind of greasy and on light sandy soil the fruit is deficient in texture and flavor.

Fall Pippin will do well on similar soil to Northern Spy or Tompkins King, except that it prefers a fine loam rather than one quite so open in texture as is desirable for Tompkins King.

Jonathan, Grimes Golden and Tompkins King all do well on an open texture loam with a light clay loam subsoil. The Tompkins King will grow well enough on such, but the Jonathan and Grimes Golden will both need feeding. Jonathan will need considerable thinning at all times. Grimes Golden should be planted where the Rhode Island Greening tends to become a fall apple and may in such a location be planted on similar soils to the Rhode Island Greening.

Oldenburg, Wealthy and Wagener do well on soils that are deep, strong, mellow and loamy, with a clay loam subsoil, the subsoil should not be too heavy. Wagener, owing to its weak growth, should be located on rich land to keep the trees growing strongly.

Rome Beauty may be planted on soils similar to those mentioned for the Baldwin and where the Baldwin becomes a fall apple. In addition its area tends to dovetail into the Baldwin area provided the soils are fine sandy loams.

Stayman. This tree is such a strong grower that it should not be planted on too rich a soil. A fine sandy loam with loam or light clay subsoil, is better than a heavier soil. The apple needs to be encouraged to color well and this can be secured by planting on lighter soils.

Ben Davis and Gano usually reach their highest development on deep well-drained soils and in the northern areas they should be planted on sandy loams, in fact, early soils, but such must be well supplied with moisture if the fruit is to get size and yet must be light enough in texture so that they may color.

Green Newtown (Albemarle Pippin). The ideal soil has been stated to be the Porter loam, a rich dark brown, heavy mellow loam, underlain by a clay loam. The apple needs a rich soil, something like that which is ideal for growing good Rhode Island Greenings.

Winesap is grown successfully on the Hagerstown loam in the valley of Virginia, the Cecil loam on the Piedmont plain, the Clarksville loam in Northern Alabama, and in these localities a good rich loam is a satisfactory soil. It may not be as rich as that required for Green Newtown, because the apple has to color. Farther north, into New Jersey, it is grown on sandy loams, but on such it needs considerable feeding in order to get size.

Arkansas, Mammoth Black Twig. The tree is a strong and luxuriant grower, and on rich soils is often a shy bearer. It should be planted on soils not good enough for Rhode Island Greening and Grimes Golden, on heavy loam and clay loams in poor condition, on shales and sandy loams of low value, in poor condition or somewhat weak, where the wood growth can be easily held in check.

York Imperial. This variety grows south of the Baldwin area, on a wide range of soils; doing best on deep friable silty to clay loams, in good heart and relatively rich in lime.

The idea to grasp is that soils differ radically, and that the moisture-holding power, volume of air in the soil, temperature, bacterial life, all physical and mechanical conditions as well as the chemical composition have an influence for good or ill upon the plants put to live on and in them, and that some work has been done in an elementary way to determine the importance of some of these factors. One of the most practical ways is to study the conditions under which a plant thrives and then try to duplicate them. With this in mind the United States Bureau of Soils is mapping the soils of the country and before planting, one should study their local conditions and start with as few handicaps as possible, selecting the variety which promises to best fill all conditions.

Suggestions About Varieties for Certain Sections

Apple Varieties in New England States

Maine: The northern portion—Wealthy, Fameuse and Dudley; for the southern portion—Baldwin, Northern Spy, Rhode Island Greening. (Hitchings.)

New Hampshire: Rhode Island Greening, Baldwin, Northern Spy, Fameuse, Blue Pearmain, McIntosh, Tompkins King, Nodhead, Roxbury Russet, Gravenstein, Wealthy, Hubbardston, Tolman Sweet. (Gourley.)

Vermont: Rhode Island Greening, Northern Spy, Baldwin, Wealthy, Fameuse, McIntosh. (Cummings.)

Massachusetts: Baldwin, Northern Spy, Rhode Island Greening in Franklin County. Same plus McIntosh, Red Astrachan, Wealthy and Yellow Transparent in Worcester County. Gravenstein, Oldenburg, Roxbury Russet, Hubbardston and Williams are suggested for various points in addition to above.

Rhode Island: Rhode Island Greening, Baldwin, McIntosh, Northern Spy, Gravenstein, Wagener. (Adams.)

Connecticut: Baldwin, Rhode Island Greening, Roxbury Russet, Northern Spy, McIntosh, Winter Banana, Delicious. Others add Opalescent, Wealthy, Fall Pippin, Golden Russet, Wagener. (Hale.)

Middle Atlantic States

New York: Baldwin, Rhode Island Greening, followed by Northern Spy, Tompkins King, Twenty Ounce, Wealthy, Oldenburg, Ben Davis, McIntosh. Others add Rome Beauty, Opalescent, Fall Pippin. (Hedrick.)

New Jersey: Yellow Transparent, Oldenburg, Williams, Gravenstein, English Codling, Starr, Wealthy, Twenty Ounce, McIntosh, Grimes Golden, Stayman, Baldwin, Rome Beauty, Delicious, Paragon. Summer apples are commercially important. (Blake.)

Pennsylvania: For high elevations in Northern Pennsylvania—same list as New York; for Southern Pennsylvania—Stayman, York Imperial, Delicious, Grimes Golden, Rome Beauty, Jonathan, Winesap, Smokehouse.

East and North Central States

Ohio: Rome Beauty, Ben Davis, with Willow Twig in the East, Rhode Island Greening and Northern Spy in the North. Stayman, Winesap and York Imperial in the South. (Green.)

Indiana: North—Baldwin, Northern Spy, Rhode Island Greening; Central and southern—Grimes Golden, Rome Beauty, Winesap, Stayman, Ben Davis, Jonathan. As fillers, Yellow Transparent, Wealthy, Oldenburg, Wagener. (Richards.)

Illinois: Ben Davis, Gano, Jonathan; also Rome Beauty, Grimes Golden, York Imperial, Stayman, Winesap, Delicious, Minkler, Willow Twig and Ralls. Summer apples—Yellow Transparent, Oldenburg, Benoni, Maiden Blush, Red June, Early Harvest, Wealthy.

Michigan: Baldwin, Northern Spy, Rhode Island Greening, Fameuse, Oldenburg, Wealthy, Red Canada, Wolf River, Wagener, Yellow Transparent.

Wisconsin: Little commercial. Oldenburg, Red Astrachan, Yellow Transparent, Longfield, Northwestern Greening, Wolf River, Wealthy, Fameuse, Dudley, Patten Greening. (Cranefield.)

West and North Central States

Minnesota: Little commercial but Oldenburg, Wealthy, Hibernal, Charlamoff, Northwestern Greening, Wolf River. (Cady.)

Iowa: Jonathan, Grimes Golden, Ben Davis, Gano, Winesap, Black Twig, lead in the older orchards. New Plantings in the South, Delicious, Stayman, Ingram. In the North, Wealthy, Malinda, Northwestern Greening. (Watrous.)

Missouri: Ben Davis, Gano, Jonathan, Ingram, Winesap, Arkansas (Black Twig), York Imperial, Grimes Golden, Delicious, Limbertwig. (Whitten.)

North Dakota: Not commercial but Wealthy, Patten Greening, Hibernal, Oldenberg, Iowa Beauty. (Waldron.)

South Dakota: Not commercial but Oldenburg, Wealthy, Lowland Raspberry and other hardy varieties. (Hansen.)

Nebraska: Winesap, Jonathan, Ben Davis, leading commercial varieties, also the following,—Oldenburg, Yellow Transparent, Red Astrachan, Wealthy, Gano, Grimes Golden, Missouri Pippin. (Cooper.)

Kansas: Grimes Golden, Jonathan, Winesap, Stayman, Arkansas (Black Twig), Rome Beauty. For early apples, Yellow Transparent, Wealthy. (Dickens.) York Imperial, Ben Davis, Gano, Delicious, King David also suggested.

South Atlantic States

Delaware: Yellow Transparent, Williams, Early Ripe, Wealthy, Stayman, Jonathan, Paragon, Winesap, York Imperial, Nero, Grimes Golden. Summer varieties are important. (McCue.)

Maryland: Western—Northern Spy, Tompkins King, Baldwin, Rhode Island Greening, on higher elevations. On the eastern portion and in lower elevations, Jonathan, Stayman, Grimes Golden, Winesap, Paragon, Nero, Delicious. In older orchards, Ben Davis and York Imperial are seen. (Beckenstrater.)

Virginia: York Imperial, Winesap, Ben Davis, Green Newtown (Albermarle), Arkansas, Grimes Golden, Stayman. Some add Rome Beauty. (Price.)

West Virginia: York Imperial, Ben Davis, Gano, in new orchards these are being dropped and Stayman, Arkansas (Black Twig), Grimes Golden, Winesap, Baldwin, Delicious, Northwestern Greening are grown. On higher elevations, Rome Beauty. On the highest elevations, Baldwin, Tompkins King, Rhode Island Greening, Fallawater, Northern Spy. In the southern portion of the state, Stayman, Rome Beauty, York Imperial, Ben Davis, Grimes Golden, Jonathan, are the commercial apples. (Alderman.)

North Carolina: Standard northern varieties are grown on the highest elevations. Varieties adapted to more southern states on lower levels. (Hutt.)

South Carolina: In the Piedmont regions there are few commercial plantings. In the mountain regions, most of the leading commercial varieties are grown. The following lead, Stayman, Winesap, Rome Beauty, Delicious, Kinnard. (Newman.)

Georgia: Some apples are grown in the mountain regions. (McHatton.) In Western Georgia, Stayman, Limbertwig, Yates, Rome Beauty. (Folger.)

Western Florida: Not commercial, but Jennings and Red Astrachan. (Rolfs.)

EAST AND SOUTH CENTRAL STATES

Kentucky: Winesap. Others add Stayman, Ben Davis, Rome Beauty, Paragon, Limbertwig and summer varieties. (Mathews.)

Tennessee: Ben Davis, Winesap, York Imperial, Limbertwig and summer varieties as Early Harvest, Red June, Yellow Transparent, Horse.

Alabama: Not commercial; but Red June, Red Astrachan, Yellow Transparent, are grown in a small way. Arkansas (Black Twig), Winesap, Shockly, Yates, Ben Davis, Delicious, Champion, Hackworth are grown in the mountain region. (Williams and Duggar.)

Mississippi: Not commercial; but Early Harvest, Red June for home use only. (Tracy and Lewis.)

WEST AND SOUTH CENTRAL STATES

Arkansas: Ben Davis, Gano, Winesap, Jonathan, Arkansas, York Imperial, Grimes Golden, Ingram, Givens, Collins, Beach, Stayman, Delicious, King David. For summer apples, Oldenburg, Horse, Buckingham, Red June, Red Astrachan. (Walker.)

Louisiana: Not commercial. In the northern part of the state, Horse, Red June, Mangum, Early Harvest, Cullasaga, Shannon. (Tiebout.)

Oklahoma: No commercial production. Ben Davis, Jonathan, Missouri Pippin sometimes planted. (Booth.)

Texas: Some grown in northeast Texas. (Munson.)

MOUNTAIN STATES

Montana: McIntosh in Bitter Root Valley. Others add Rome Beauty, Wealthy, with Delicious and Wagener in a small way. (Dean.)

Idaho: Northern portion depends on rainfall. Southern portion is irrigated. Jonathan, followed by Rome Beauty, Winesap, Stayman.

Wyoming: Little commercial. Suggestions, in altitudes above 6,000 feet—Yellow Transparent, Oldenburg, Tetofsky, Wealthy; between 4,500 feet and under 6,000 feet, above mentioned with Longfield and Patten Greening. Below 4,500 feet above mentioned, with Wolf River, Northwestern Greening, McIntosh, Winter Banana, Jonathan. (Nelson.)

Colorado: Most orchards irrigatel. North Colorado—Ben Davis is the leading variety, but it is not being planted; in other districts, Jonathan, Rome Beauty, Winesap and Gano lead. (Bennett.)

New Mexico: All orchards irrigated. In the warmer regions—Jonathan, Rome Beauty, King David, Ben Davis, Gano, Winesap, Arkansas (Black Twig), Arkansas Black; in the cooler and higher altitudes—same varieties except Monmouth, Arkansas, King David and Arkansas Black; in their place use Stayman, Delicious, Grimes Golden, White Winter Pearmain. Some early varieties such as Yellow Transparent, Red June and Early Harvest are also grown. (Garcia.)

Arizona: Irrigated. Ben Davis, Arkansas Black, Gano, White Winter Pearmain, Jonathan, Limbertwig and others. (Forbes.)

Utah: All orchards irrigated. Jonathan, Winesap, Rome Beauty, Ben Davis, Gano, Arkansas, Winter Banana, Rhode Island Greening. (Batchelor.)

Nevada: Little commercial, all orchards irrigated.

PACIFIC STATES

Washington: Rainfall quite variable, as high as 100 inches along the coast; 9 inches in eastern portion, in latter case irrigation is practiced. Irrigated valleys: Winesap, Jonathan, Delicious, Esopus Spitzenburg, Rome Beauty, Stayman, Yellow Newtown. (Folger.) Non-irrigated areas—Rome Beauty.

Oregon: Esopus Spitzenburg, Green Newtown, with York Imperial, Rome Beauty, Gano, Jonathan to a lesser extent. Gravenstein, Tompkins King and others near the coast. (Lewis.)

California: Watsonville District: Yellow Newtown, Yellow Bellflower. Sebastopol area: Gravenstein for fall, Esopus Spitzenburg for winter use. Twenty varieties to less extent in other parts of the state, including White and Red Astrachan, White Winter Pearmain, Winesap, Rome Beauty.

CANADA

The province of Ontario may be divided roughly into six districts where the climate is sufficiently different to warrant some difference, even though slight, in the varieties recommended. (Macoun.)

District 1: Counties north of Lake Erie: Summer—Red Astrachan, Oldenburg. Autumn—Gravenstein, Wealthy, Blenheim. Early Winter—Tompkins King, Hubbardston, McIntosh, Fameuse, Rhode Island Greening. Winter—Baldwin, Northern Spy.

District 2: Counties on Lake Huron and the southern part of the Georgian Bay and inland to Wellington and Waterloo counties: Summer—Red Astrachan, Oldenburg. Autumn—Gravenstein, Wealthy, Alexander, Blenheim. Early Winter—Tompkins King, Rhode Island Greening, McIntosh, Fameuse. Winter—Baldwin, Northern Spy.

District 3: Counties on Lake Ontario north to a line south of Lake Simcoe on the west and covering to Kingston on the east; Summer—Oldenburg. Autumn—Gravenstein, Wealthy, Alexander, Blenheim. Early Winter—McIntosh, Fameuse, Rhode Island Greening. Winter—Baldwin, Northern Spy. Baldwin is too tender in some places. Additional varieties suggested for trial, home use or local market for districts 1, 2 and 3, Yellow Transparent, Primate, Ribston, Swazie, Tolman Sweet, Rome Beauty.

District 4: Counties of Wellington and Waterloo and the higher elevations in the adjacent counties: Summer—Oldenburg. Autumn—Wealthy, Alexander. Early Winter—McIntosh, Fameuse. Other varieties such as Gravenstein, Blenheim, Ribston and Northern Spy will succeed in the most favorable parts, but it is safer to top graft them.

District 5: From near Kingston, north and east to latitude 46 degrees and along this line west to and including Manitoulin Island, and south to District 3: Summer—Yellow Transparent, Crimson Beauty, Oldenburg, Langford. Autumn—Wealthy, Alexander, Dudley, McMahon. Okabena is promising. Early Winter—McIntosh, Fameuse, Wolf River. Winter—Milwaukee, Bethel, Scott. Scarlet Pippin succeeds well near the St. Lawrence River but it is not hardy enough inland. Additional varieties suggested for home use: Summer—Lowland Raspberry. Autumn—Peach of Montreal, St. Lawrence. Winter — Pewaukee, Golden Russet, Tolman Sweet. While a few winter varieties are recommended for this district, extensive plantings of them are not advised.

District 6: North of District 5. Summer—Blushed Calville, Lowland Raspberry, Oldenburg and Charlamoff; the two latter being autumn varieties in this district. Autumn—Golden White, Antonovka, Wealthy, Hibernal, McMahon, Longfield. Where apples will not grow, the following crab apples should be tried: Whitney, Transcendent, Florence, Martha and Hyslop. Where the climate is most severe the hybrid crab apples originated at the Central Experimental Farm, Ottawa, such as Silvia, Jewel and Charles should succeed.

Quebec: The province of Quebec may be divided into two districts so far as the growing of apples is concerned.

District 1: North to latitude 46 degrees and south to the American boundary, in the western part of the province and east to the counties of Lotbinière and Dorchester, south of the St. Lawrence River, and on the north side within five miles of the St. Lawrence River, from about Three Rivers, east to the Island of Orleans; and then again south of the St. Lawrence River within a few miles of the river from Nicolet County to L'Islet County. Where there are high elevations or especially unfavorable conditions of soil, the varieties for District 2 would be the better to plant. Summer—Yellow Transparent, Crimson Beauty, Oldenburg, Langford. Autumn—Wealthy, Alexander, Dudley, McMahon, Okabena is promising. Early Winter—McIntosh, Fameuse, Wolf River. Winter—Milwaukee, Bethel, Scott. Additional varieties suggested for home use: Summer—Lowland Raspberry. Autumn—Peach of Montreal, St. Lawrence. Winter—Pewaukee, Golden Russet, Tolman Sweet. While a few winter varieties are recommended for this district, extensive plantings are not advised. Bethel is not very hardy and should not be planted in the coldest parts of this district.

District 2: North of latitude 46 degrees, north of the St. Lawrence River; and south of the St. Lawrence River in the counties of Rimouski, Matane and Gaspe. Summer—Blushed Calville, Lowland Raspberry, Oldenburg and Charlamoff; the two latter being autumn varieties in this district. Yellow Transparent will succeed in the most favorable parts. Autumn—Golden White, Antonovka, Wealthy, Hibernal, McMahon, Longfield and Patten Greening, all of which might be called early winter apples in this district. Where apples will not grow the following crab apples should be tried: Whitney, Transcendent, Florence, Martha and Hyslop. Where the climate is most severe the hybrid crab apples originated at the Central Experimental Farm, Ottawa, such as Silvia, Jewel and Charles should succeed.

PRINCE EDWARD ISLAND

Autumn—Oldenburg. Early Winter—Wealthy, Alexander. Winter—Tompkins King, Ribston, McIntosh, Northern Spy, Roxbury Russet and Stark. Other varieties which might be grown for home use especially are: Summer—Lowland Raspberry, Yellow Transparent. Autumn—St. Lawrence and Gravenstein. Early Winter and Winter—Grimes Golden, Golden Russet.

On Prince Edward Island the summer and autumn varieties especially, keep much longer than in any other places in Canada—Gravenstein and Wealthy, for instance, keep well on into the winter, hence the term ''autumn'' for these as grown on Prince Edward Island may be somewhat of a misnomer.

NEW BRUNSWICK

The following information in regard to varieties of apples in New Brunswick is taken from the report on Horticulture for the Province of New Brunswick for the year 1914.

Not recommended at all: Ben Davis, Gano, Gideon.

Not to be planted on their own roots except in the most southern sections: Northern Spy, Baldwin, Rhode Island Greening, Tompkins King, Gravenstein, Yellow Bellflower (Bishop Pippin), Ribston, Blue Pearmain, Blenheim and Ontario.

In the best sections of Albert, Kings, Charlotte, Queens, Sunbury, Westmorland, and York counties, Yellow Bellflower (Bishop Pippin), and Blue Pearmain can be grown successfully by top grafting on hardier stocks, such as Tolman Sweet, Alexander and McMahon. While good specimens grown top grafted of Northern Spy, Gravenstein, Baldwin, Tompkins King, Rhode Island Greening and Blenheim have been shown, and they may be grown for home use, they are not recommended for commercial plantings, except perhaps to a certain extent in the southern part of Albert and Charlotte Counties, where the climate is milder and they do well.

South of a straight line drawn east and west from Woodstock to Shediac, the following varieties have proved hardy and valuable: Summer—Crimson

Beauty, Red Astrachan, Yellow Transparent. Autumn—Oldenburg, New Brunswick and Dudley. Early Winter—Wealthy, Alexander, Wolf River, Fameuse, McIntosh, Ribston (best top grafted). Winter—Yellow Bellflower (Bishop Pippin) top grafted, Bethel, Canada Baldwin and Tolman Sweet. Additional winter varieties well worthy of trial are Milwaukee and Northwestern Greening. Scott and Golden Russet have both proved hardy, but the former being a shy bearer, is recommended for home use only.

North of the same line the following varieties are recommended: Summer—Crimson Beauty, Yellow Transparent. Autumn—Oldenburg, New Brunswick, Dudley (doing well in the demonstration orchard on the North Shore). Early and Midwinter—Wealthy, Wolf River, Fameuse, Alexander, McIntosh. Winter—Scott, Red Canada, Winter St. Lawrence, Milwaukee.

Some of the varieties mentioned in the southern district may prove hardy enough for the northern section, but they have not been sufficiently tested yet to recommend them as reliable.

For commercial apple growing, where the orchards will range larger, the Fameuse, McIntosh, Bethel and Yellow Bellflower will find a ready sale at good prices on the local markets. For export purposes omit the Yellow Bellflower and add Oldenburg, Dudley, Wealthy and Alexander or Wolf River.

NOVA SCOTIA

Annapolis and adjacent valleys: Summer—Crimson Beauty, Williams. Autumn—Gravenstein, Wealthy, Alexander. Early Winter—Tompkins King, Ribston, McIntosh, Blenheim. Winter—Northern Spy, Wagener, Stark, Baldwin and Golden Russet. Other good varieties which do well there are Yellow Bellflower (Bishop Pippin), Roxbury Russet (Nonpareil), and Cox Orange.

Eastern Nova Scotia: Summer—Crimson Beauty, Yellow Transparent, Oldenburg. Autumn—Dudley, Wealthy, Alexander. Early Winter—McIntosh. Winter—Golden Russet, Stark. The possibilities of this part of Nova Scotia are not fully demonstrated yet. In places some of the other varieties recommended for the Annapolis Valley will succeed.

Colder parts, including Cape Breton: Summer—Crimson Beauty, Yellow Transparent. Autumn—Oldenburg, Dudley. Early Winter—Wealthy, McIntosh, Wolf River. Winter—Bethel, Golden Russet. Other varieties will do very well in places and are particularly useful for home use. Summer—Red Astrachan, Charlamoff. Winter—Ribston, Tolman Sweet, Blue Pearmain, Pewaukee, Grimes Golden and Northern Spy.

APPLES RECOMMENDED FOR PRAIRIE PROVINCES

Apples in the most favored situation. Blushed Calville, Anisette, Oldenburg, Charlamoff, Lowland Raspberry, Beautiful Arcade (Pepka Kislaga), Patten Greening, Antonovka, Hibernal. Crab Apples—Transcendent, Florence, Virginia, Hyslop. Saunders' Hybrid Crab apples,—Jewel, Charles, Silvia, Prince, Tony, Robin, Elsa and Norman. These are about the size of other named crab apples, but hardier.

British Columbia

There are so many climates in British Columbia due to the many valleys, to the difference in elevation, and to the difference in humidity that without dividing the province into a great many districts for which lists of best varieties are given, the fruitgrower might plant a variety in a certain district which would be quite unsuited to it. Even within these districts, however, there are high or low elevations or peculiar climatic conditions and the prospective grower must not follow the general list too closely, but judge for himself as to whether his climate is representative of the district and, if not, what other district has a climate most like it. For the very coldest places where apples are grown only with the greatest difficulty, or where it is doubtful if they will succeed at all, we should recommend trying the varieties recommended for the prairie provinces, otherwise, Yellow Transparent, Oldenburg, Wealthy are grown generally followed by McIntosh, Jonathan, Wagener, Grimes Golden, Gravenstein, Blenheim, Alexander and others.

CHAPTER VI

THE TREES WE PLANT

In the case of apples it is customary to plant one- or two-year-old "buds" or two- or three-year-old "root grafts,"—trees budded one or two years previous, or the grafts made two or three years previous. The three-year root graft and the two-year bud are the same age.

Buds. The nurseryman buys seedling apples. Sometimes he plants these in April or May and buds them in August. A year after that fall the trees are one-year old and are sold as one-year buds. Practically all peach, cherry, plum, pear, quince and citrus fruits are propagated in this way.

Root grafts. Whole root and piece root: In the root graft, the root is taken off the seedling when received in early spring or during the winter. The graft, perhaps 4 or 6 inches long, is worked onto it by whip grafting. It is held in place by three or four winds of a piece of thin twine or tape, the latter preferred, and is put away in sawdust to "callus." This is planted in the spring at the same time as the seedlings. After it has grown two seasons it is a two-year graft; when grown three seasons it is a three-year graft. In the Southern states it is possible to dig these as one-year grafts, for by that time they may have made a growth of 3 or more feet. The graft may be made on the whole root of the seedling or on a piece of the root and is spoken of as a "whole-root" graft or "piece-root" graft, according to the amount of root used.

Roots of buds. The roots of a budded tree or a whole-root graft, usually present a much better appearance when the tree is two years old than do those of a piece-root graft, hence the planter usually desires them. So far as experiments in the United States have been conducted, it appears that the piece-root graft tree is just as good as any in the orchard. These lack finality and more and better work is needed. At Woburn, England, in a comprehensive test the results favored the budded tree and in apples the two-year-old tree was the best to plant.

How to produce hardy apple trees. For sections where the climate is unduly severe as in Maine, Wisconsin, Minnesota and parts of Canada, it is very important to have the roots of a stock more hardy than the French crab, which is usually used for apples; for such localities it is advised that roots of hardy crabs be used or piece-root grafts be made, using a very small piece of root, probably 2 inches with a long scion, and that these be planted quite deep so that the scion may take root as well as the stock. In this way the roots will be as hardy as the trunk and not so susceptible to winter killing. The roots of such varieties as McIntosh, Hibernal, Oldenburg, Fameuse or of those varieties grown in the territory mentioned are frequently sufficiently hardy to exist there. Residents of these localities should be particular to secure the trees which have been grown in the proper way.

Time to cut scions. It is usually advised to cut scions in the fall, as soon as possible after the wood has matured. The value of this is well brought out by figures given by Professor Macoun of Ottawa, Canada, in regard to results secured in the cold winter of 1917-18. The first lot of scions was cut December 5 and 6, 1917; the weather then turned continuously cold and no more were cut until February 13, 1918. On cutting the second lot it was recognized that a large proportion had been injured, the pith being brown. The records of the two lots are given below:

Roots grafted, Winter, 1917-18.
Scions taken, December 5 and 6, 1917.
Stock: Seedlings of Orion Crab, 24 varieties.
Number of grafts made, 885;
Number of grafts which grew, 559;
Percentage of grafts which grew, 63.16.
Roots grafted, Winter, 1917-18.
Scions taken, February 13, 1918.
Stock: Seedlings of Martha Crab, 22 varieties.
Number of grafts made, 607;
Number of grafts which grew, 112;
Percentage of grafts which grew, 18.45.

Compare both of these with results from root grafting in the winter of 1916-17, taking the record of one page of the grafting book—25 varieties.

Number of grafts made, 1,583;
Number of grafts which grew, 1,362;
Percentage of grafts which grew, 86.

The stock were seedlings of Excelsior crab. The same man made all the grafts. The winter of 1917-18 was very severe on nursery stock, thus three-year-old apple trees, embracing some 300 varieties and 319 lots of trees at Ottawa, Canada, showed only 10.97 per cent not killed back, and of these 60 per cent were crab apple hybrids. If one is cutting wood for topworking trees the above suggestion is just as timely as it is for the nurseryman.

Influence of stock on scion in regard to hardiness. From the work done by Dorsey in Minnesota it would appear that the hardiness of the scion is independent of the stock, and if a hardy stock has an influence upon the hardiness of the scion it is not sufficient to prevent injury by low temperatures. The topworking of varieties such as Tompkins King, Hubbardston, Jonathan, etc, upon hardy trunks with the expectation that one can make them grow where they otherwise would not live on account of their lack of hardiness, does not seem to be well founded.

Northern and southern grown trees. It is not of much moment whether the trees planted were grown in a northern or southern nursery, but it is important that they will grow under northern conditions if they are to be planted in the north. Today little attention is given to the roots, although in the future more attention will be given to this part of the tree. Some roots appear to be well adapted to specific varieties while others are not, and the study of these relationships should be made.

Planters requirements. Planters usually do not know their needs. At the present time the planter buys what the nurseryman offers. The aim seems to be to get as large a tree as possible for the money. Owing to this desire to give size the nurseryman sometimes heads back trees which are not growing vigorously in order to get a top which shows perhaps two years of growth although it may have been headed back once or perhaps twice and thus be actually four years old. It is therefore important for the fruitgrower to deal direct with a nurseryman in whom he has confidence, who will tell him absolutely what is sold; by dealing direct with a reputable firm, the grower gets the history of the tree.

Appearance of the tree and its size. Usually a straight trunk is wanted. In some varieties this is easily secured. Varieties such as Stark, Baldwin and Northern Spy grow straight, but in other varieties such as Rhode Island Greening apple, or Bosc or Winter Nelis pears, the tree is apt to be a little crooked near the base or in the trunk. This will not be seen five years after planting. It is seldom that a variety such as Williams can be made to produce a tree over five-eighths inch in caliper and over 5 feet tall in two years, while Stark grown alongside would make a tree 7 feet tall in the same time, so that it has become accepted among nurserymen that any tree, a two-year bud or three-year graft of standard apple, pear, plum or sweet cherry 5 feet to 7 feet tall and eleven-sixteenths inch in caliper, 2 inches above the bud is a first class tree and of the largest size; anything which is 4 feet to 5 feet tall and five-eighths inch caliper is second size; and anything 3 feet to 4 feet tall, and one-half inch caliper is third size. Sometimes a fourth size, 2 to 3 feet tall and three-eighths inch in caliper is made. In the sour cherry, especially a variety as Morello, it is frequently impossible to get the tree much more than 4 feet tall at two years old.

Peach. In the peach, the trees are all sold as one-year old. A tree nine-sixteenths inch caliper and 5 feet tall is first size; seven-sixteenths inch caliper and 4 feet tall is second size, and a tree from 2 to 3 feet in height is third size. In southern nurseries, and sometimes in those of the north, trees will make an inch in caliper and be 7 feet tall or more in one season, but the planters do not desire such big specimens. This is especially true if the lower limbs have been rubbed off and one wishes to head them low because the trunks of such fail to furnish many dormant buds.

Quince. In the quince, a tree five-eighths inch in caliper and 5 feet tall is first size at two years. Fruit trees differ entirely from ornamentals in that age is considered, whereas in the ornamentals size is the only consideration. In other words, fruit trees are grown for commercial purposes; ornamentals are grown merely for gratification and personal desire; that is their ultimate end, and the height and bushiness of the plant is of prime importance. Fruitgrowers are probably paying too much attention to size. Many successful planters are preferring the medium-sized trees, trees of normal growth under average conditions. Our commercial trees are more apt to be too large rather than to be too small for the most economical production of fruit.

What to do on arrival of the trees. If the trees arrive dried out it is safe to throw them into water and leave them there for twenty-four hours. If they are frozen do not unpack them, but put them in a basement where they will thaw out gradually. When ready to plant the trees should not be unduly exposed and if one is not ready to plant at the time they may be unpacked, and trenched or heeled in. This is better than leaving in the case.

Heeling in. To heel or trench cut the bundles, place the trees with their roots singly in a trench, shovel fine soil among the roots, and when the trench is partly filled with soil, thoroughly soak with water and finish covering the roots. The soil should be packed tightly around the roots so that they will not dry out; in this way they may be held until ready for planting. Be sure that the soil fills the cavities around the roots, otherwise mice may get into the trench and eat the roots.

Inspection of the trees. It will pay to examine carefully each tree before planting. Trees should be examined for borers; this is especially true in the peach. The roots can be examined for the presence of root troubles,—galls, aphis, etc.,—and defective trees be segregated. A certain percentage of the trees will be injured in packing and such may be planted where they can receive a little extra attention. Today the inheritance of the tree is not considered, save in the case of citrus fruits in California. If San José scale is on the trees they may be dipped in one of the standard remedies, but generally speaking it is inadvisable to dip the roots.

Inspection for frost injury. In the nursery trees are sometimes injured by sharp autumn frosts which occur before the wood is matured. This was noted in a climate mild as that of British Columbia in 1912, when a temperature of 13° F. previous to digging time, October 24, 1912, caused discoloration just below the cambium layer of all trees examined. There was a bursting of the bark in one case in the variety Esopus Spitzenburg and Yellow Newtown, and a slight discoloration in one tree out of ten of Northern Spy, but none in the Wealthy. In McIntosh a slight discoloration was seen in one tree out of ten, while all Wagener trees showed discoloration. The injury may vary in degree from a slight browning below the cambium layer to browning of the sap wood without injury to the cambium layer. The trees so injured will continue to grow, even though they are subjected to the same conditions annually. In some cases the cambium may be killed and death of the part affected will follow or the whole of the tree may die.

Removing labels. All labels should be removed from the trees and no wires left to girdle them. This may be done when the roots are inspected for pruning or later when the tops are pruned.

Size of the tree. The size to which the tree has attained in the first two years is not an index of the size it will attain, nor will the largest trees continue to be the largest after growing ten years. The author, while preferring a good-sized tree, cannot at the end of ten years, and fifteen years after planting, detect any difference between Baldwin trees which were five-eighths inch in caliper when set and those which were three-fourths inch in caliper. Any tree well grown is commercially desirable; and some apple orchards planted with the trees which were but one-half inch in caliper at two-years old have made just as profitable orchards. These trees attained a diameter of one-half inch at two years because that was their capacity in the time they had. The seedlings used for their roots may have been trees of slower growth or shorter growth and yet in time might attain a size which is ample. A dwarf tree is not regarded as inferior to a standard tree because it is not of the same size in a given period of time. These smaller-sized standard trees may be of ample size for modern conditions.

With peaches, few growers want the largest trees. The average seems to be most in favor, while some demand the small sizes. "Many men, many minds," but just what the essentials are to be sought for in a tree are not known. Planters usually want a big tree, plenty of wood for their money, and nurserymen try to please their customers.

Size of apple tree to plant. At Kentville, Nova Scotia, apple trees fall dug and stored until spring, one-half inch, five-eighths inch and eleven-sixteenths inch in caliper were shipped from New York and planted. The largest trees did best. The smallest failed entirely; they were so dried out that they did not have sufficient reserve of vitality to start into growth. Had the trees planted been freshly dug, or had they been soaked in water prior to planting, the results might have been different. If trees are stored and planting is delayed in spring it may be advisable to use the largest-sized trees because they can tolerate the maximum amount of abuse.

Amount to prune when planting. With trees handled in the above manner the best results were secured by giving severe pruning. The records show that the trees severely pruned made a growth of 4.82 inches the first year and 20 inches the second, while those not pruned at all made one inch the first year and 2.4 inches the second. Results with trees from the same locality in New York, but planted without going into storage and near to where they were grown, gave exactly contrary results. The trees not cut back, but in which surplus limbs were removed did much better than those which were pruned back to two or three buds each. The author's experience is that with normally vigorous trees, no cutting back of the branches is desirable; in the case of two-year-old trees merely taking out the branches which are not needed is sufficient, and with yearlings the removal of all buds which are not needed, leaving four well placed and at sufficient distance apart and then removing the top few buds to force the growth of those left, is advised.

Relationship of stock and scion. The stock used may determine the size and vigor of the tree without affecting the size, color or flavor of the fruit. This is seen when the seedling crab apples are used to furnish the roots in the production of standard apple trees, the Doucin for the production of semi-dwarf trees and the Paradise for the production of dwarf trees. The Doucin and Paradise apples occur wild in Central Asia and there are small trees or shrubs. Commercially, dwarf-growing types of these are multiplied by layering. Seedlings of Doucin and Paradise are not used for reasons given later. The scions often affect the root system of the seedlings and layers to such an extent that some of the men in the nurseries can tell the varieties by the roots. From the same lot of stocks the Rhode Island Greening trees will have a spreading root system, Oldenburg, Northern Spy and Whitney crab a deep-rooting system, and Yellow Transparent a shallow rooting system, etc. In about 50 per cent of root grafts made of common varieties as Baldwin, Northern Spy, Gano and others the trees develop roots from the scion, or above the union, and such trees are practically on their own roots. The relationship existing between the stock and scion is little understood. The quince, when used as a stock, dwarfs the pear, but in many cases the quince root which carries the pear has a much greater root development than it would have if it were carrying a quince top.

The root stocks we use. At the present time, seedlings of various fruit stocks are grown by specialists who make this their business. In a seedling bed of any fruit there will usually be found considerable variation in the size and character of the plants. Some will, when mature, make tall trees, others dwarf; some will be deep-rooted, others shallow; some are more subject to root diseases than others; in fact we frequently have a collection of plants from which on inspection we could secure many types. A rough system of classifying is adopted by grading the seedlings into sizes. Thus in native grown American seedling apples they are sized as one-fourth inch caliper and over, three-sixteenths inch, and two-sixteenths inch. The largest sized seedlings in a general way may be regarded as the strongest growers, although some of the next size may be all we need so far as size is concerned. Taking one hundred of the largest seedlings at one year old, all will not make large trees. Some which grow rapidly while young have been found on reaching maturity to be dwarf in stature. At the Long Ashton and at the East Malling Research Stations, Kent, England, a careful study was made of fruit tree seedlings. Since we use European grown seed and seedlings extensively the facts are of suggestive value to us. The results show:

1. That the seedlings of "French Crab"* apples (English "Free" stock) are not uniform in character but may be tall growing or dwarf, and that certain distinct types are common.
2. That seedlings of so-called Paradise or Dwarf stock show similar variation and certain types occur with frequency. Some plants raised from such seed are just as tall growing as the so-called Crabs; hence we cannot reproduce from seed but multiply individuals known to be of dwarf habit by layering.
3. The root stock influences the variety worked upon it, influencing the size of the tree, the age at which it comes into bearing, and the yield; in addition, some root stocks possess good root anchorage, while others have poor; some sucker freely and others do not; some are more resistant to root troubles than others. Size of tree is not a matter of health. It may be a matter of inheritance of the stock.
4. Generally speaking, at least four distinct types of apple stock can be found, as follows:
   (a) A very dwarf stock, suitable for growing cordons and very dwarf trees. The best stock for this purpose known to the trade is the Jaune de Metz or Yellow Paradise (Malling type IX). The growth is very dwarf on this stock, the root system is shallow and the tree needs staking.
   (b) The semi-dwarf or bush trees are secured by using the Doucin or English Paradise (Malling type II), and the Improved Doucin

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* Much of the so-called "French Crab" seed has in the past been gathered in Austria and Central Europe for the French trade, little is gathered in France and the trees used to furnish same are a motley lot.

(Malling type V) are similar. These trees need staking if the head is heavy.

(c) The broad-leaved English Paradise (Malling type I), introduced by Messrs. Rivers of England about 1860 is more vigorous than those in group (b), and is used as a root for weak-growing varieties. The Nonesuch (Malling type VI), is similar. These stocks make standard trees on good soils.

(d) The most vigorous type of all, usually used for standard trees. So far seedlings have been used to furnish the nursery trade, but two stocks were segregated—Malling types XIII and XVI—and these are securing fairly wide distribution.

None of these types can be propagated from seed and maintained true to type. They are grown from layers or by some other vegetative method.

Root stocks. Pear seedlings grown in Europe show as much variation as apples. Some types of quinces have a much greater dwarfing effect upon pears than others. The Angers quince is one of the most free-growing. In plum stocks the maze of variation is even more marked. In cherries, the author's experience in trying to bud so-called Mazzard cherry seedlings is such that he was forced to recognize one type as practically worthless; it seemed to be impossible to secure a satisfactory union of the bud with it. There was no affinity. Some varieties of plums make trees of largest size when budded on Myrobalan stock but they may be longer in coming into bearing. St. Julien stock would dwarf the same variety. Some varieties of plums in Europe do better on their own roots than when budded on any known stock, the trees bearing more regularly, larger crops, and being longer-lived. Japanese plums do well on peach stocks and such are as long-lived as the trunk. The whole question of root stocks is one which might well receive careful study, and nothing should be taken for granted.

American or foreign seedlings. The United States Department of Agriculture is working on this problem. The indications are that seedlings grown from some American source may be satisfactory for use. For two years, they have tried to get a stand of seedlings from Baldwin seed and failed. Seedlings of McIntosh produced strong, vigorous plants, and seedlings of Tolman Sweet gave a high percentage of clean, straight roots.

Apples on known roots. Shaw of Massachusetts finds that McIntosh and Stayman make strong trees on their own roots, while Oldenburg, so far, gives an inferior root. McIntosh on Transcendant Crab makes a strong growth, while Red Astrachan on the same stock is remarkably dwarfed. Northern Spy roots have a dwarfing effect, both here and in South Africa, and this is very marked when Yellow Transparent is budded on it. The author found that Twenty Ounce is dwarfed remarkably by working on Northern Spy. Northern Spy and Paradise roots tend to cause a little earlier bearing in McIntosh, Wagener, Primate, Chenango and Yellow Transparent. Seedlings of Winesap show the poor root system of this variety. Seedlings of Ben Davis show root systems like the parent.

An Indiana grower states that Ben Davis is an ideal stock upon which to topwork Rome Beauty, Delicious and York Imperial, that the two woods unite nicely and make an even growth. Delicious does not do well on Benoni, outgrowing the Benoni stock, and the union is weak. Northern Spy worked on Ralls is a failure. The Northern Spy is such a slow grower the union is poor. Grimes Golden was improved by working it on Ralls and Delicious united well with Ralls. In Australia and South Africa, the Northern Spy and Winter Majetin are used as stocks because they are immune to woolly aphis. The Siberian crab root is stimulated when it carries a cultivated apple above ground instead of its own trunk and top. The trifoliate orange (*Poncirus trifoliata*) shows the same thing with citrus fruits.

Rooting cuttings. Shaw has shown that there is a wide variation in the ability of twigs of apples to take root. Of fourteen varieties tried, Tolman Sweet cuttings produced but 3 per cent of rooted trees, while Sweet Bough produced 98 per cent. Generally speaking, the softer the wood the easier the scion rooted. A well-drained sandy loam soil seems most favorable for rooting cuttings of apples. Root cuttings can be used for the propagation of some apple trees although the growth may be slow the first year.

Once a variety is on its own roots it may then be propagated as follows:

(a) by stem cuttings if the variety lends itself to the method; sometimes soft wood cuttings are easier made than hardwood.

(b) by root cuttings.

(c) by mound layering.

(d) by a combination of root cuttings and mound layering.

If we standardize our roots, it can be done only by the selection of a root stock and the vegetative multiplication of same as now practiced in the production of Paradise and Doucin apple layers. This is slow, and root cuttings are perhaps more promising; but a combination of root cutting and layering may be a solution. The roots of a desirable plant are gathered and cut into lengths of a few inches during the early spring. They are planted as soon as possible in the spring, usually in rows 4 feet wide and 1 to 2 inches in the row, with the apex about 1 inch below ground. Each root may send up three to ten shoots and it will generally make new roots. As the shoots grow, the earth is worked around them to induce them to take root. These rooted plants may be handled like seedlings, being taken up in fall and planted in the nursery row the following spring. This method can be used on apple stocks, Pyrus ussuriensis, Pyrus calleryana, Myrobalan, St. Julien, Mazzard, Almond and Sour Orange.

Resistant stocks. The root of the Persian walnut tree is not as hardy as its trunk and top and is extremely sensitive to black alkali. By using native black walnuts, the Eastern for the Eastern United States, the Texas for the Southwest, the Northern and Southern California black walnuts for their respective areas, we are enabled to grow this tree successfully where it might not otherwise succeed. The Northern California black walnut is reported to be immune to Armillaria. The same is true of French pear seedlings. The Japanese pear which is somewhat resistant to pear blight, is used as a stock for pears. Pyrus ussuriensis and Pyrus calleryana and other Chinese and Indian pears are promising as stocks on account of their blight-resisting power. The work done thus far shows that individual plants vary widely in their ability to resist fire blight and that it will be necessary to isolate a suitable individual and then multiply it by some vegetative method.

Congeniality between stock and scion means long life and success; uncongeniality means failure. In one instance in California, the grafting of almond on peach so stimulated the growth of the roots and the top of the tree that the trees grew 50 feet tall and had trunks 2 to 3 feet in diameter. At forty-two years of age the trees were perfectly sound and healthy, this being a very congenial union; while nearby almond trees on plum, topworked at the same time, showed a very uncongenial union; the plum stock was smaller than the almond and most of the trees were dead at forty. Some varieties of pears do not unite well with the quince. In practice they are double

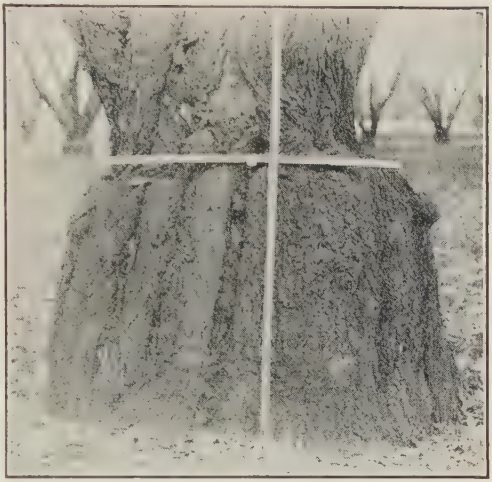

FIG. 9. Almond on Peach stock. A good union producing long-lived, productive and profitable trees. The stock is a stronger grower than the scion placed on it

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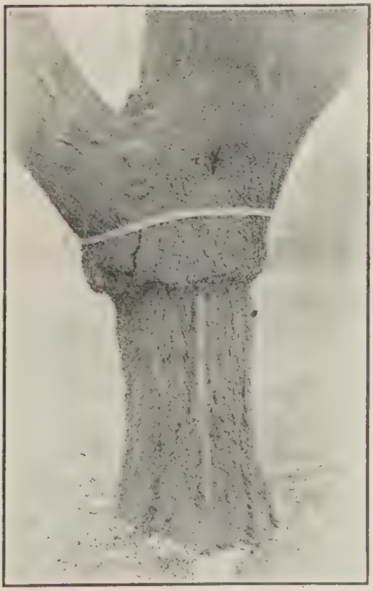

FIG. 10. An Almond on Plum stock. A poor union, uncongenial and much shorter-lived than almond on peach. The scion grew faster than the stock

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worked, being budded or grafted on the trunk of perhaps Duchesse d'Angoulême, which makes a fairly good union with the quince, although Hardy is preferred by many. Seckel and Beurré Bosc pears do not always make a good union when topworked on Kieffer. Some varieties of apples are better as stocks than others. Where topworking in the Northeastern states is desired, Tolman Sweet is more frequently a congenial trunk than Northern Spy; Paragon appears to be one of the most desirable further south.

Graft hybrids. Grafting may extend or reduce the period of life and increase or diminish the size and stature of both plants used or of one. Gradually, however, we are beginning to realize that in some cases the influence does not cease at this point. Generally, we have not been able to see any extension of the character of one plant into the other, but in one case when a tomato was grafted on a belladonna plant, an alkaloid allied to atropin was found in the tomato plant although normally it does not occur in tomatoes. In other instances it was found that the plant resulting from such a union might be a tomato at heart, with the outward appearance of a nightshade or vice versa.

A peach was grafted on an almond; the first year it bore a crop of peaches, the next year some of the buds produced by it were like those of the almond while others were peach buds. Seeds from its pits produced trees which in foliage resembled both peaches and almonds. In these latter cases, we have so-called graft-hybrids, in which the cells of the stock grew alongside, or inside, of those of the scion and appeared from time to time.

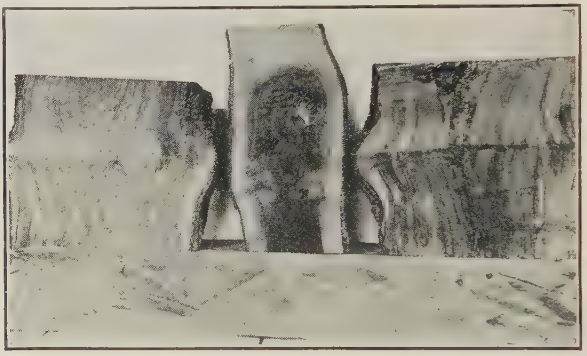

Fig. 11. Sectional view of a mature grafted tree—Peach and Almond. In these we see that the common course has been followed, the cells of the almond and the peach lie one on top of the other. None of the peach cells have grown up with the almond cells
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Chimeras. In some cases, the stock may not remain stationary at the point of union, but will grow inside the scion like the finger in a glove. If the glove is broken, the finger shows through and such plants are known as Chimeras. They are much more common than is realized. The Bizzaria, a citrus graft-hybrid, bears fruit, flowers and leaves resembling the orange, lemon, citron and lime; it was recorded in Florence in 1644, and has been reproduced ever since by budding and grafting. The variegated geraniums and Coleus are Chimeras. A chimera is a plant composed of tissues of two different plants. In other words, when we graft a scion on a stock the result may be more complex than we have been led to expect, although fortunately for us commercially, it generally follows a certain known course.

In one case on record, Winkler, a German botanist, who made 268 grafts of belladonna and tomato, secured a plant which was new to science. It was distinct from either parent and must be recognized as a true graft-hybrid. It is as distinct as though it had been produced by sexual means. It has been proven that a graft-hybrid is a possibility.

Apple chimeras. The frequent occurrence of apples which appear to show characteristics of two varieties has led many to assume that such are the results of cross-pollination. A Golden Russet was grafted onto a Boston Stripe. A bud or buds developed at the point of union of the graft in which the characters of both varieties were carried. From time to time the characteristics of both varieties appear in the fruit. Similar results have been seen with olives and other fruits

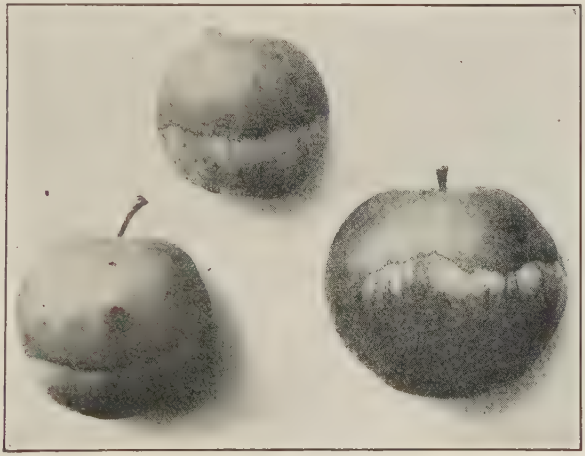


FIG. 12. An apple chimera. Two varieties of apples in one. This is not the result of pollination. It is the result of grafting a Boston Stripe on a Golden Russet tree. A bud or buds developed at the place of union of the stock and scion and both varieties grew together so that from time to time the cells form fruits which are partly from one variety and partly from the other, while the rest of the fruit may be wholly of one variety or the other. This condition is common with many fruits and with other plants propagated by means of graftage or budding

CHAPTER VII

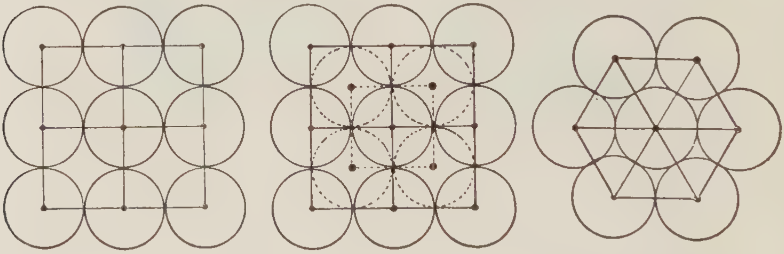
PLANTING PROBLEMS

The arrangement of the trees in the orchard is now a matter worthy of considerable thought. Where land is cheap and labor dear and sunlight costs nothing but space, the arrangement is quite different from that where land is costly and labor cheap. The latter condition is rapidly passing in all civilized countries, but it is always relative. The function of the tree is to bottle sunshine. It needs air, water and space to get the sunshine. Sunshine costs nothing. It is not like labor. It works for standing room only, but it must be able to get to the tree.

The square system. In New York, most of the orchards are planted on the square system,—each tree is located on the corner of a square or a rectangle.

The equilateral triangle. In some of the irrigated valleys of the West, the trees are located on the corners of equilateral triangles. Land is more costly and by this arrangement, even when the trees are the same distance from each other, a larger number of trees can be planted to the acre.

Rectangle. From each of these systems, we find modifications. Thus, instead of being planted in squares, the figure may be a



Square System

Quincunx

Equilateral Triangle or Hexagonal

FIG. 13. Arrangement of Trees in the Orchard

Square System	Quincunx	Equilateral Triangle or Hexagonal
Admits of cultivation in four directions. Has four open spaces for each tree. Has greatest facilities for spraying, harvesting, etc. About 22 per cent of the space is not occupied by the circles but the roots of the trees will find it.	Admits of cultivation in four directions. Has about 70 per cent of its space doubly occupied. Has no facilities for spraying, harvesting, etc. Is often used when the plan involves removal of part of the trees	Has six open spaces for each tree. Facilities for tillage, spraying, harvesting, etc., are good. Only 10 per cent of space not in the circles. Carries 12-15 per cent more trees than the square and spaces them better

rectangle to give a greater distance between the rows in one direction, a wider space being left from east to west, than from north to south; in other words, the wide rows run north and south.

Isosceles triangle is frequently called the triangular system, but it should be called the isosceles triangular system because it bears the same relation to the equilateral triangle that the rectangle does to the square. The base of the triangle is shorter or longer than the sides.

The Quincunx is a modification of the square and rectangle, and consists of planting a tree in the center of each square or rectangle, thus doubling the number of trees on the acre. Frequently the trees so planted are of a more or less temporary nature, the object being to let them grow for a few years and then remove them, leaving the permanent trees in the square or rectangular form. Thus peaches are used between apples, oranges, lemons, pecans, walnuts, etc., and removed as soon as they have borne a few crops.

Hedge planting. Where land is expensive or intensive cultivation is given and labor is not too important a factor, hedge planting has a place. The plants are given a wide space in one direction and are closer in another; they form a hedge. Heavy yields of fruit can be secured in this way. It is in common use with small fruits, raspberries, currants and sometimes quinces and dwarf pears.

Double planting. Where land is very valuable, permanent and semi-permanent apples or other tree fruits may be planted and the space between planted to bush fruits which will stay a few years. For the first year or two the whole area is filled up with strawberries or a truck crop. It is successful where skill is displayed in controlling all and removing a bush or tree as soon as it should be removed and before it has injured the permanent neighboring tree, which is of more value.

The approximate number of trees per acre for different planting systems are shown on page 76.

A useful distance for apple trees is in squares about 32 feet apart, and thin to quincunx, which will leave the trees 45 feet apart. This will permit of growing farm crops between the trees for many years and thus reduce the expense of getting the orchard into bearing.

TREES PER ACRE FOR PLANTING SYSTEMS

Distance apart-feet	Triangular	Rectangular	Hexagonal	Quincunx
10 x 10	396	436	501	831
12 x 12	275	303	348	523
15 x 10	264	290		
15 x 15	175	193	217	347
20 x 15	132	145		
18 x 18	122	134	142	247
20 x 20	98	108	124	199
25 x 20	79	87		
25 x 25	64	70	81	126
30 x 30	44	48	55	83
35 x 35	33	36	41	65

Preparation of the land. In the East when the trees are to be planted in sod little preparation of the land is usually given. In some places the wet spots may be underdrained, the herbage cut, the holes made and the trees planted. This is not the usual course of procedure even in the East. In the West where irrigation is to be practiced the land is first graded to facilitate the distribution of the water. In most cases fall plowing of the land is advised East and West. If in need of underdrainage it can usually be done more economically before planting the trees. If the land is newly cleared, and root-rots may be present, it may be wise to crop for two or three years before planting. If in poor condition it will probably be as economical to bring up the productivity of the soil by means of fertilizers, tillage and cover crops during the early years of the orchard as to delay the planting.

Fitting the soil. The land can be fitted before the trees are planted if the conditions are favorable, but it is not advisable to delay the spring planting of trees too long in order to prepare the soil. It is frequently much better to start the work as early as possible in the spring, while the soil is perhaps still a little too moist to work with teams, because a gain of ten days to two weeks in the first year is frequently of much more value to the tree than will be secured from merely having the soil cultivated before it is planted. Of course cultivation of the soil is not to be neglected but performed as soon as possible.

Time of planting. The actual planting should be done as early as possible in the spring, or in the fall in favorable localities. In Canada, except in British Columbia and in regions such as the Central Western states where dry cold conditions prevail in the winter, fall planting is undesirable. In New York and New England it is not wise to fall plant one-year-old trees. The wood is not sufficiently mature except perhaps in the case of sweet or sour cherry. In the apple the foliage is carried so late in the fall that spring planting is advised. Peaches should be spring planted, but two-year-old apple, pear or plum may be fall planted in the most favored regions. Further south and on the Pacific Coast planting is done during January and February.

Spring planting is the rule because nurserymen are usually so busy in the fall getting the trees dug and stored that it is impossible to get them into the hands of the planter in time for fall planting; and further, if a tree is dug too early, before the leaves begin to fall naturally, no benefit accrues to the tree. Many trees are seriously injured if dug too soon. In the main, the bulk of trees is not sold to the planter by the man who grows them. Growing trees is a business in itself. The grower frequently sells the trees wholesale or grows them on contract for a wholesaler who stores in the fall and during the winter sorts them ready for early spring delivery.

Pruning the tree. The pruning given to the roots need not be very elaborate. The end of a broken root may be cut off straight, but whether it slopes one way or another does not matter. A very long root may be shortened if desired. The work of Pickering at Woburn, England, shows that in most cases trimming the roots is of no value and in the case of red currants it was actually detrimental. If the tree is in healthy condition and well supplied with moisture it is not necessary to cut back the branches. It is best, however, after the tree is planted to remove any unnecessary limbs, leaving perhaps three or four and a leader in the case of apples, pears and plums, and perhaps sweet cherries, but in peaches and sometimes sour cherries the center is removed.

Pruning shrivelled trees. If the trees have been in storage for a time and have shrivelled at the tips of the branches, it may be necessary to shorten them to living vigorous wood. It should, however, be remembered that strong, vigorous growth is not antagonistic to early bearing and a profitable tree, that the object in planting the tree is to have it grow and to attain the largest size in the least time, without making excessive wood growth. With this in view, it is folly to remove from the trees, the buds which will start first,—the terminal buds.

The terminal bud. The terminal bud is the chief care of the tree. It often starts into growth ten days earlier than a latent bud nearer the trunk. Therefore, whenever possible save the terminal buds if you wish to encourage wood growth.

Laying out the orchard. It is frequently quite difficult for the beginner to lay out the orchard. One easy way on rolling land is to take ordinary laths, which are 4 feet long. Having decided on the distance for the trees, proceed to put in the laths in a straight line along one side of the field from the southeast corner A to the southwest corner B and if the field has a fence at right angles to this first line, stake it also to a point C. This gives two sides of a square or a rectangle. Now erect another perpendicular on the other end of the first line, i.e., from the southeast corner A toward the northeast corner D and of equal length to the south line B C and then measure across the north line C to D to see that it is right; if not right readjust the end of the third line i.e., that to the southwest corner D and close the square. It is not imperative that the square be absolute. If it is 2 or 3 inches off it does not matter, although in particular work one could have a surveyor's instrument and erect these right angles. In some instances where the land is free from stone and easy to plow, furrows may be plowed out from stake to stake each way. It is essential that the men go out and come back in the same furrow, not plow one out and then bring another furrow back, for if such be done there will be a wide row and a narrow row.

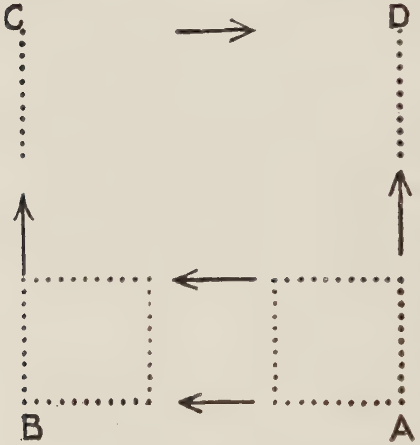


Fig. 14. Course to follow in staking out a field for planting

Digging the holes by hand. When the holes are to be dug by hand, after having marked the place for each tree on the four sides of the rectangle by means of a lath, sight in all the interior stakes. Two men, with a third man to hold the lath and drive it home where the hole is to be, will lay out a field when they have had some experience and stake every hole at a cost of 60 cents per acre, with labor at $1.50 a day. This is four hours of labor for one man per acre. In this way the whole square is filled with laths before a hole is dug. When the men begin to dig the rule is to dig four holes and then leave one lath; that is in every square 16 holes are dug and surrounded by standing laths. When the planters come along they use the standing laths to sight on and fill in the sixteen vacancies. As they come to the lath which has been left they dig the hole and plant the tree. It is always important to sight from one direction and not work up the field and then work back again, but always work upward. In this way if there is an error at any time it is carried in the same direction all the time. If a tree is 2 or 3 inches out it does not matter; in fact, it may not matter if it is 6 inches because it will not be more than two or three years before the growth of the tree covers it up and one tree goes one way and another the other.

Making the hole by dynamite. Where the subsoil is compact or an impervious layer lies close to the surface, both of which conditions are undesirable, it is suggested that the trouble be overcome by dynamiting the hole. Much benefit has followed from such treatment under these conditions. Even where none of these conditions prevail breaking up the subsoil with dynamite in the place where the tree is to stand may be desirable. It may be detrimental if the work is done at the wrong time, for if the charge merely makes a pocket below ground, and time is not given for the soil to settle back the tree may die from lack of water. It is advised, therefore, that the dynamiting be done some months previous to time of planting in order to permit of a proper readjustment of the subsoil. A satisfactory hole for a tree cannot be made by dynamite as cheaply as by a man with a shovel.

The planting board. When the holes for trees are to be dug by hand some planters make use of a planting board. This is a piece of light board 1 inch by 6 inches and 5 or 6 feet long, notched on the ends and with a notch on one side in its center. When in use the center notch is so placed as to enclose the stake which occupies the site of the tree. Two pegs are now driven in the end notches, and the board is picked up, the center stake removed, the hole dug and the board returned to its place. It is well always to arrange that the notch in the board is to point west or south at all times. The tree is placed with its trunk in the central notch where the stake was and is planted, the two end pegs being removed for further use. Other methods consist of having a planting board with a hinged leg; it saves removing the board to dig the hole. The leg is merely thrown back until needed for placing the tree.

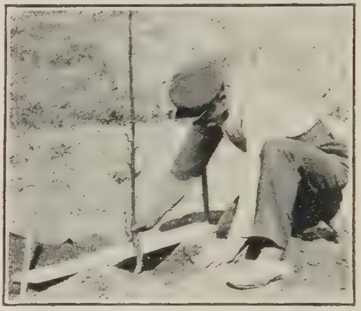


Fig. 15. One form of planting board, also showing that the tree is planted about the same depth it formerly was in the ground. Too deep planting and too shallow planting are inadvisable

Chain method. Where the land is level the end stakes only are located and a chain is used to plant by. A link is marked where each tree is to go. The trees are planted on one side of the chain; and when the row is finished, the chain is carried forward for the next row. It is quite efficient where a big crew is working. By its use no time is lost in sighting. The chain must be kept uniformly taut.

Distance to plant in New York. The planting distance varies with the locality and the men. In western New York, where apple trees grow large, it is wise to plant so as to allow such varieties as Rhode Island Greening and Baldwin ultimately to have 50 feet of space each way. It may be possible to interplant for a term of years with a variety such as Wealthy, Rome Beauty or Wagener at 25 feet. A better way may be to plant the four permanent trees and the semi-permanent of the same variety so that nothing but the diagonal will be different and when the first thinning is given there is but one variety left in the block. Some of the best planters believe that it is more economical to plant nothing but one variety in the block, having permanent and filler the same. If it is wise to plant different varieties for the purpose of pollination, plant four permanent rows of one and four rows of the other alternately. Many commercial growers question the wisdom of planting fillers. They are not often taken out on time.

In New England. On thin land in New England apple trees may be planted 40 feet apart. Fillers are sometimes planted at 20 feet but their duration is short, relatively speaking, although some early bearing variety such as Wealthy or a small growing tree like Wagener which is also apt to bear early will give fairly good returns in that time. Yellow Transparent, Williams, Oldenburg, Rome Beauty and others may be used.

In Central states. In the Central states apple trees are frequently planted 20 feet apart but their life is short. It is a mistake to plant trees too close together. Their branches interlock and the lower limbs die and nothing but a small top remains. The bearing surface of such a tree is scant. Sunshine is free, the tree's work is to bottle it. It cannot do it unless there is space enough between the individuals for the sun to shine into and onto all the foliage.

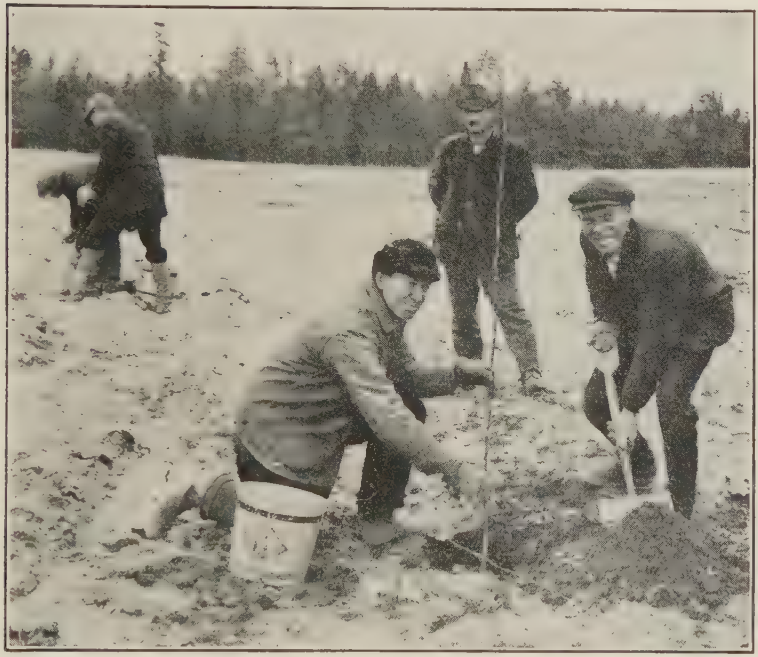


FIG. 16. Planting with a chain at Seabrook Farms, Bridgeton, N. J. 1,500 acres of apples and peaches were planted at an actual labor cost of $2.70 per acre. The chain carries a tag where the tree is to be and when the row is planted the chain is carried forward to the next row. The apple tree is a yearling whip, it has no branches. Each tree receives a handful of fertilizer when set

In Pacific Coast states. From 20 to 30 feet apart, depending upon the variety and location; although in districts where the trees are longer lived 40 feet may be none too much for the permanent trees. Trees are generally set too close together and fillers are not taken out soon enough. Some growers have come to realize that in Wenatchee and Yakima, Washington, Winesap trees should not be set closer than 30 feet; Delicious 36 to 38 feet, while Rome may be set 25 feet apart. In recent years the injurious results from too close planting is being seen in the size of the fruit. The Yakima Fruit Growers' Association data show an appreciable increase in the number of five-tier or small-size apples as the trees grow older. In 1917 there were 27.5 per cent five-tier Winesaps; in 1918, 32.5 per cent; in 1920, 50 per cent; in 1921, 51.5 per cent. The price received for these five-tier apples was less than the cost of production. While size may be increased by fertilization, pruning and thinning, the one factor usually overlooked is giving the tree an adequate amount of space.

In Canada. In Ontario and Nova Scotia a distance of 35 to 40 feet apart is considered desirable for winter apples. In the colder parts of Ontario, Quebec, New Brunswick, Northern Nova Scotia and Prince Edward Island 30 to 35 feet apart is deemed desirable. In British Columbia 30 feet apart each way is satisfactory. In the prairie provinces of Canada 20 feet apart each way is sufficient.

Macoun of Canada suggests that when fillers are used between apple trees planted less than 40 feet apart in favorable locations in Canada, that the fillers be omitted in alternate rows to facilitate work in the orchard, let the trees stand 40 feet by 20 feet. Early bearing varieties like Wealthy may be planted 15 feet apart in blocks of six rows each. Omit a row for the passage of the sprayer and wagons for hauling the fruit off. The trees may later be thinned to 30 feet apart. This is possible in the hands of those who will give special attention to the trees. Macoun reports the production of a Wealthy block planted in 1896, 10 feet by 10 feet or 435 trees to the acre to be satisfactory.

Size of hole. In digging for citrus fruits in California some authorities favor large holes—2 feet wide and 18 inches deep and the loosening of the bottom before planting the tree. For deciduous fruits on good soil there seems to be no particular reason for doing this. Where the soil is suitable there is no need to make a hole larger than necessary to accommodate the roots and permit one to get their feet in to pack the soil tight.

Packing the soil around the roots, and being sure that no cavities are left is the most important thing in planting.

Water must pass from the soil into the tree if the tree is to grow. Water enters the tree by means of the roots. It cannot enter the roots unless they are in contact with the soil; therefore the need of packing the soil tightly around the roots. When replacing the soil, take a shovel full of fine soil and throw it over the roots. The person holding the tree should then move it up and down a few times to permit the soil to fall in among the cavities under the roots, letting these finally rest on soil throughout their entire length, like a brick rests on mortar or a stone on cement in a wall. With a short stick or the shovel handle pound this fine soil firm between the roots, then put on more soil and tramp it firm with the feet. By the time the hole is half full the tree will be standing quite firmly held in the soil; replace more soil which may be tramped tight and finish by leaving on the surface 3 or 4 inches of fine loose soil and let it be slightly mounded in the case of deciduous trees so that water will not stand round the tree.

Placing the tree. With apples, when the soil settles the tree should stand a little deeper than it did originally in the nursery. At Cornell University apple trees deeply planted produced a top about 22 per cent heavier than similar size trees shallow planted. When placing the tree, if other conditions do not dominate place it with its lowest strong limb in the direction of the prevailing wind. It is always a struggle to keep the tree symmetrical, the windward side being lacking in wood development.

In England, Spencer Pickering in a most comprehensive series of experiments extending over twenty-five years, showed that trees planted in small holes with their roots cramped, in which the soil was pounded firm round the roots gave better results, grew better and bore more fruit than did those planted in larger holes with what is usually regarded as ''more care.'' The ''abused'' tree did best, even though it did not grow as well the first year it was planted.

Arrangement of men in planting. The arrangement of the men depends upon circumstances. The following has been used by the author for planting on hilly land. Where a block of trees are to be set it is wise to arrange a party of three who stake out the field, a party of four to dig the holes, three may be ample if the soil is sand and the holes small. Two planting gangs of three each, two to shovel and one to hold the tree and tramp it firm: this man is responsible for the planting done. Two men are used to sight the trees in position. A team and a man haul trees if the distance is considerable. If in trenches nearby, two active boys are needed to carry and distribute the trees, not too far in advance of the planters. At least one man will be needed to examine the trees before planting and to cut any roots which need cutting.

Pruning of the tops should be done after planting. It is well to leave the training of the trees in the hands of one man for the first ten years in order that continuity of purpose may be maintained. Trees intelligently handled for the first ten years are then ready for business. With an organization as outlined, the daily planting may be expected to range from forty to 100 trees per man, depending upon conditions.

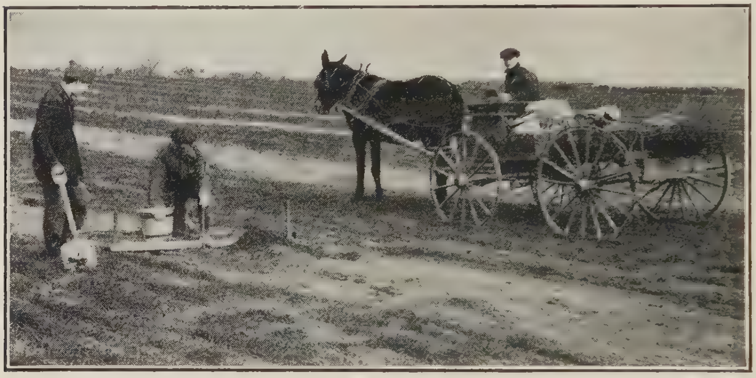


FIG. 17. Using the planting board in filling in trees which died or failed to make satisfactory growth at Seabrook Farms, N. J. The wagon is used to haul trees and fertilizer. A handful of bone meal or other fertilizer is applied at the time the tree is planted

Timeliness in planting. It is desirable that planting be finished in the first month of spring, although trees held in storage are often planted much later in the season with success. There is no one time. There is usually a time which is the best for a stated set of conditions. If one has the money to pay the cost, fruiting apple trees may be moved while in leaf and bearing fruit. It is merely a matter of time and money and knowing what to do and how. That is all there is to any problem in fruit growing.

CHAPTER VIII

TOOLS FOR TILLING

In no branch of farming is it more imperative to have all work done on time than in growing fruit. The large investment and heavy annual expenditure, must be maintained whether a crop develops or not. The fact that a lack of a detail may jeopardize if not destroy the results for the year warrants the purchase of the most up-to-date tools. The labor requirement in fruit growing is so great that almost any expense for tools which will reduce labor is warranted. On the small farm where animals are used as motors the single mold-board plow and ordinary one- or two-horse harrows and cultivators will be used. The best horse-drawn tools to select will depend upon local conditions.

Orchard cultivators. Where the soil is broken up without plowing, or where it is full of quack grass or similar weeds, and where the soil is somewhat difficult to handle, the California orchard cultivator is one of the most useful of orchard tools. If used with a pole it may be hard on the horses' necks; hence the use of a truck and stub pole is preferable. In this tool the changing of the teeth is easily accomplished; narrow, wide, shovel or blade-like teeth can be used. It is equipped for working the land 5 or 6 inches deep. On many soils three horses are required to handle a tool $6\frac{1}{2}$ feet wide.

Light draft harrow. This tool is well adapted for fitting free-working soils or for maintaining a mulch. The harrows are made in wider sizes than the orchard cultivators and a large acreage may be covered in a day. Those made for use with the tractor may cover the entire space between rows of trees.

Spring-tooth harrow. This well-known tool is satisfactory on stony land and is well adapted to fitting land to a depth of 2 to 4 inches after plowing. It is made in sections, the harrow being of various widths. This tool fines the soil particles by pushing them against each other and compacts the soil in the process.

Cultivators. In various parts of the country special cultivators have been built to meet local requirements. Some consist of wooden frames to which teeth standards are attached and on which the teeth may be bolted. The teeth in common use for breaking the land are diamond-shaped and reversible. Such tools often enable one to break the crust of several acres of orchard in the time that otherwise might be occupied in plowing, thereby getting the surface broken and a soil mulch established in less time.

The disk harrow. This is an excellent tool for cutting up sod, weeds, trash or rubbish, and working land which may not be in condition to be fitted by a spring-tooth harrow or similar tool. With its rolling motion and cutting edge, this tool cuts and pulverizes the soil and leaves it much less compact than does the spring-tooth harrow. As it pulverizes it tends to lighten the soil. The disk works better on land which is not too stony. On stony land a harrow in which each disk can rise independently of its gang is desirable. The disks may be solid or cut-away. The latter are preferred for newly cleared land where the roots are many, and for stony land. The spading harrow in which the disk is made up of several knife-blade-like sections is a modified disk.

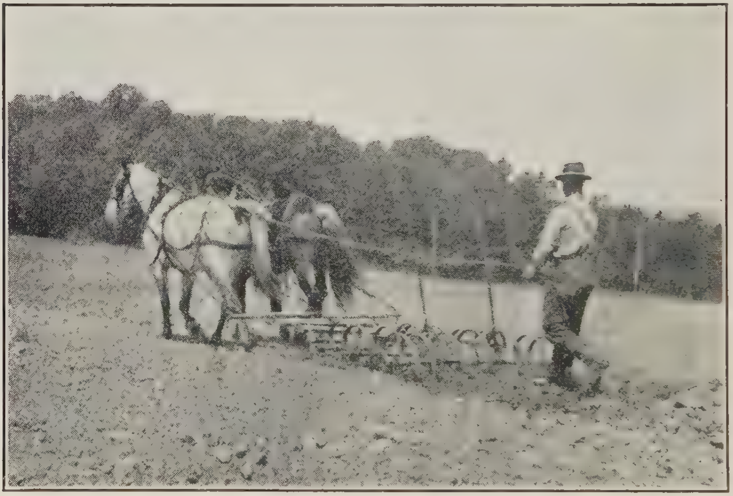


FIG. 18. Fitting the land for the orchard with the spring-toothed harrow, in Pennsylvania

In these tools the inclination of the disk to the line of draft can be changed by means of levers. This determines the depth at which the tools will work. In the horse-drawn tools the disks are usually from 12 inches to 16 inches in diameter; those for tractor use are 18 or more inches in diameter, and are fastened to a frame in gangs. They may be in a single row, as in the single-action disk harrow, or in a double row when the disk is said to have double-action. In these tools if the front set of disks throws the soil outward, the rear set throws it inward so that the soil is left more nearly level than when the single disk is used. With a good tractor and disk harrow, an orchard can be quickly worked.

The Acme harrow consists of several blade-like teeth attached to a frame. The blades have a twist somewhat like the mold board of a plow and as they are drawn through the soil they cut and grind the soil particles together. This tool is made in various sizes and is of value for maintaining a mulch, especially where there are not too many stones.

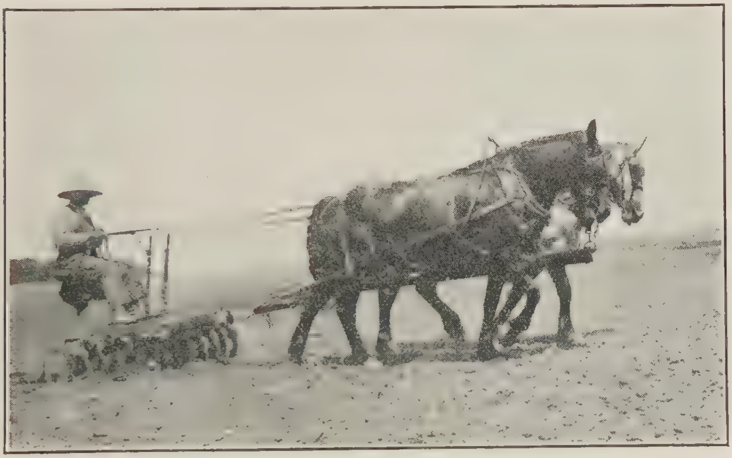


FIG. 19. A cutaway disk harrow

The Kimball cultivator is more frequently used in the West. It consists of a series of blades attached to a wooden frame. The driver stands on the frame as he would on a float. If trash gathers on the blades the driver adjusts his weight so that the tool may tilt and slide over the obstruction.

The smoothing harrow consists of a number of teeth or spikes fitted onto a frame. The teeth can be left erect or inclined backward in order to permit them to penetrate the soil to a greater or less extent. They are of value in smoothing the surface or for covering seed.

Extension tools. In order that one may work under and close to the trees extension tools may be secured. In the disk harrow these are made with a wide frame; the gangs fastened at the ends. With a team it is possible to extend the two sections of a spring-tooth harrow by taking a long evener and attaching the sections in the ordinary manner, holding the sections in position by means of two seven-eighths inches or 1-inch round iron bars. which extend diagonally across the space between the sections, fastening these where the two sections would normally be attached to each other. Where the two bars cross the under one may have a V-shaped depression for the upper one to fit in.

Rollers. The land roller is used for crushing the lumps and is one of the most useful of tools in its place. It is usually made in sections and varies in width and weight according to the common requirements of the locality. Special purpose rollers are made for crushing lumpy soils. These clod crushers, as they are termed, may consist of a series of corrugated cast-iron disks on an axle or a series of fluted bars bolted on circular end pieces. If plowed land is first rolled with a clod crusher it makes it possible to fit it quickly with the tractor-disk harrow.

Tractors. The tractor has come to stay as the motive power of the orchardist. It is important not only that the tool shall work in the springtime when the soil is muddy, but that it shall not stall because of the heat in the middle of the summer; that the sand and dust will not quickly destroy its bearings and that it shall be economical in the use of fuel and oil, as well as in repairs. It is essential that one may be able to secure repairs at once, for the tool often breaks at a time when there is great need for it. It must be low down, so that it can go near to the trees and be capable of turning with its tools in a relatively small space. The orchardist who owns one will undoubtedly secure tools that the tractor can haul. Probably two or three kinds of tools will be hitched behind each other so as to finish the orchard work as one goes over it.

About three thousand hours of actual work in the orchard has been given as the probable life of the Fordson tractor. It will vary with the skill of the operator. On an eastern fifty-acre fruit farm it is hardly likely that one could get this amount of use out of this tractor in less than three years, even when the whole area is under thorough cultivation. The cost of operation has varied, but in 1918-19 averaged about $1.50 per hour, including labor, depreciation, oil and fuel, but not the use of the plows and harrows.

CHAPTER IX

SHAPING THE APPLE TREE

An apple tree bears fruit characteristic of the variety—the fruit is similar in appearance, color, shape and in other things. But each tree shows variation to a degree. Some, as the Rhode Island Greening, grow broad and spreading and are apt to be flat: it is essential to maintain the center in them in order to get them sufficiently tall. A flat-topped, low-headed, open-centered Rhode Island Greening does not have sufficient bearing surface to be profitable. The Wealthy and the Twenty Ounce tend to make narrow upright trees. The aim should be to get them to spread, and yet in the Wealthy, the tree loads so heavily that it is not advisable to grow it as an open-centered tree because it may tear apart; hence it is advised to leave the

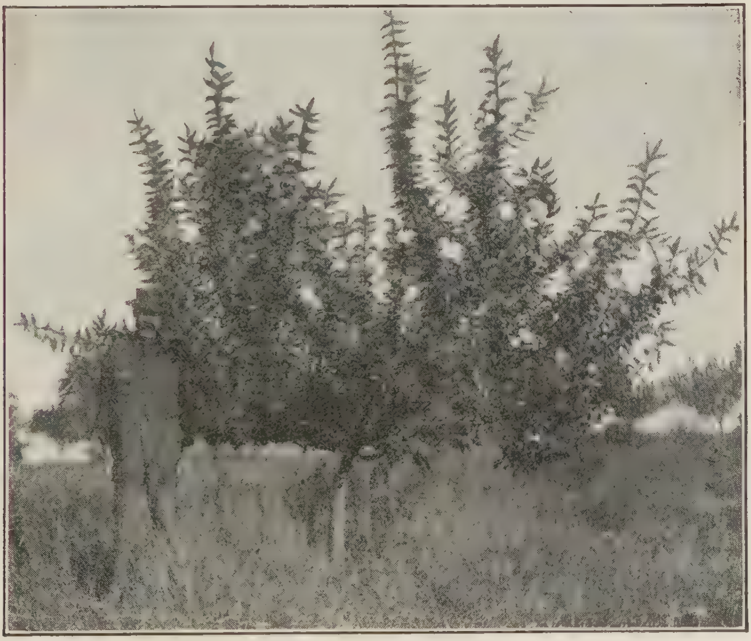


FIG. 20. An open-center Rhode Island Greening apple tree. Such a tree will never be profitable, it has not sufficient bearing surface.
Edward Van Alstyne, New York

center in and space the main limbs at least a foot apart on the trunk so as to divide the weight of the load. This is a wise procedure with all varieties for the first five years of life. In my judgment it is impossible to make a satisfactory head for eastern conditions at the time the tree is planted. It may be done with the peach. However, if a head is made in the first five years of an apple tree's growth it is doing very well. So long as the tree is growing upward and is suitably heading in the right direction, little pruning is necessary,—nothing more than the removal of an unnecessary or interfering limb or of

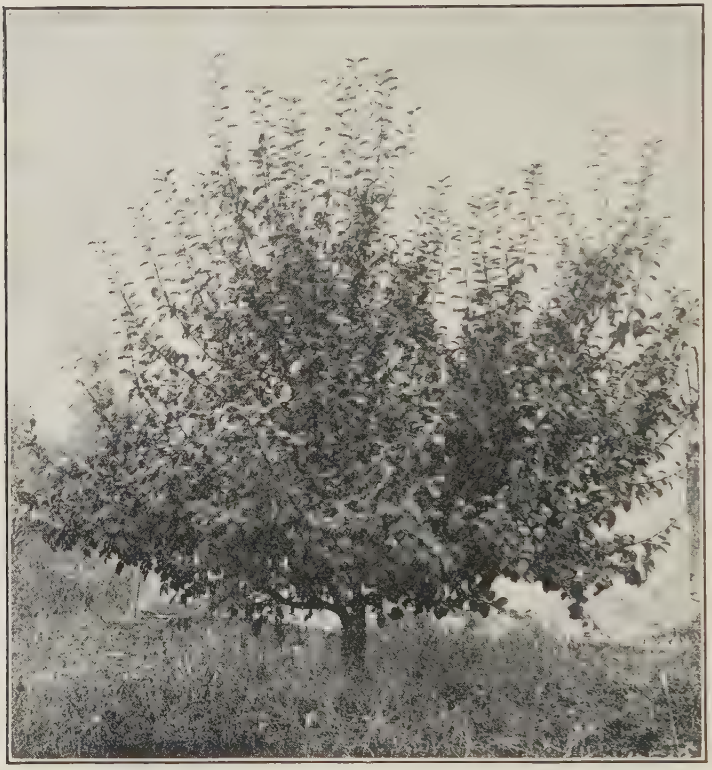


FIG. 21. Shape of Tree. McIntosh is a spreading tree. This tree is in its sixth year; it is 10 feet tall and nearly 14 feet diameter. It is growing in the same orchard and apparently under identical conditions with the Wealthy. Fig. 22. That it is growing well may be seen from the length of the current season's twigs. No pruning was given. The shape of the tree is a varietal character

Grown by the author, Geneseo, N. Y.

one going in a wrong direction. The sooner such are removed the better. If the bud could be rubbed off when starting it would be advisable.

There has been a tendency to introduce into American practice the European custom of heading back the young tree every year with the idea that the same was necessary. There are growers on the Pacific Coast who contend that it is advisable to do this with apples and such other fruits as the cherry, lemon, apricot, etc. When it is done a certain amount of summer pruning seems necessary in order to remove some of the excessive growth which is stimulated. The method causes continuous work, first in making a large growth and then in reducing it. This course of procedure is prohibitive in cost for the commercial grower. Why therefore go to this expense when it has been shown that it is absolutely unnecessary and that the tree will bear better and earlier and make just as good a specimen later if practically no pruning is given other than the removal of limbs which are apt to interfere or will not be needed? The tree may start more limbs than will be retained, but after it comes into bearing at five or six years the removal of a certain limb now and then to thin the tree and to remove a certain amount of fruit can be successfully practiced so that the tree will be given a permanent head, well distributed on the trunk by the time it is ten years old.

Do not over-prune young trees. Experiments conducted with respect to the advisability of heading back trees or leaving them alone favor as little pruning as possible during the early years of growth. By so doing, not only larger trees are made in a given time, but the trees bear larger crops. They also bear more regularly and expense is saved.

Further confirmation of the undesirability of annually heading in young apple trees comes from the Canadian station at Vineland, Ontario. It was shown that winter pruning of trees not only delayed bearing but retarded growth markedly. In a given period of time the heavily pruned trees were the smallest and bore little fruit. On the other hand, summer pruning, which consisted simply of pinching off the terminal buds from the higher branches in August after most of the growth was made while it reduced the weight of fruit and also the diameter of the trunks to a slight degree as compared with the unpruned trees, was not nearly so serious a setback as that resulting from winter pruning. It was felt that the summer-pruned trees were somewhat better shaped than the unpruned and that the loss in size was compensated for by the greater freedom from straggly branches. On the whole, summer pruning does not seem advisable.

Pruning is a dwarfing process. In England, at the Woburn station, twelve-year-old trees which had been heavily pruned were 16 per cent lighter than moderately pruned trees, while unpruned trees were 20 per cent heavier than moderately pruned trees. One of the best illustrations of the effect of regular pruning is seen in wild crab apples in pastures, where the trees are regularly browsed by cattle. The trees are low, bushy and small, but they live to an old age and bear fruit. The pruning given is a dwarfing process. Apple trees might be used for a hedge if desired. I have seen them planted in rows 15 inches apart and kept regularly pruned to a height of 6 feet and each tree bearing apples. For their size the trees were quite productive. What, when and how to prune then depends upon the object in view.

Influence of pruning on the development of the tree. In order to emphasize the above, certain data secured by the California station may be cited. The girth of the tree is a measure of its size, both tops and roots. Nonpareil Almond trees were used for a test. One block was heavily pruned, another lightly pruned and in a third block the head was thinned a little. After three years of growth the trees were dug up and the results were as follows:

EFFECT OF PRUNING ON THREE-YEAR-OLD ALMONDS

Pounds	Thinned and headed severely	Thinned and headed lightly	Thinned only
Weight of prunings	9.7	11.0	8.5
Weight of tops	19.7	37.0	39.5
Weight of roots	16.9	30.3	32.5
Total weight	46.3	78.3	80.5
Spread of roots—feet . . .	9.8	12.7	15.5
Depth of roots—feet . . .	5.0	5.5	4.7

The lighter the pruning given the heavier the top and roots. Heading back a young tree does not favor strong root development as some have stated. It checks it. The spread of roots is less in the heavily pruned tree than in either of the others. Similar results were secured in confirmatory tests under different conditions.

Influence of pruning on the stockiness of the trunk. The table on page 93 shows the average increase in circumference of trees pruned as above stated, the growth being given in centimeters.

AVERAGE INCREASE (CENTIMETERS) IN GROWTH OF YOUNG FRUIT TREES UNDER DIFFERENT SYSTEMS OF PRUNING IN CALIFORNIA

Kind of fruit	Pruned Severely	Pruned Moderately	Pruned Lightly
Apricot	11.7	12.6	15.3
Cherry	10.0	11.2	12.3
Peach	12.0	16.9	19.4
Pear	8.7	9.1	9.7
Plum, Japanese	6.3	10.4	11.3
Plum, European	7.2	8.8	9.4
Prune	6.2	7.1	8.4
Average	8.9	10.9	12.3

The thickness of the trunk is a measure of the growth of the tree. Moderate pruning on the average reduced the growth over 11 per cent while heavy pruning reduced it nearly 28 per cent. In addition there was the cost of the work. Further confirmation of this was secured with apricots in California and apples in Germany in regard to branches of trees, the results being shown below.

AVERAGE INCREASE IN CIRCUMFERENCE OF BRANCHES OF YOUNG TREES UNDER DIFFERENT SYSTEMS OF PRUNING (CENTIMETERS)

Fruit	Heavily pruned	Moderately pruned	Lightly pruned
Apricots in California	3.85	4.66	5.09
Apples in Germany	8.4	9.5	11.7

Confirmatory tests made in California on several hundred branches of two-, three- and four-year-old French prune and Bartlett pear showed the following results when these branches were headed back to 12, 24 and 36 inches of new growth. The data were taken a year after the time of cutting back. The diameter at the base of the shoot was used.

EFFECT OF PRUNING UPON THE DEVELOPMENT OF ONE-YEAR-OLD SHOOTS (CALIFORNIA)

	Shoots of equal size, pruned back to		
	12 inches	24 inches	36 inches
French prune, diameter	.57 ins.	.74 ins.	.92 ins.
Bartlett pear, diameter	1.25 ins.	1.55 ins.	1.75 ins.
Number of spurs formed:			
French prune	4.7	9.4	14.3
Bartlett pear	3.5	10.8	22.5
Total length of new shoots:			
French prune	154 ins.	230 ins.	284 ins.
Bartlett pear	80 ins.	106 ins.	132 ins.

Heading back new growth on young fruit trees is detrimental in direct ratio to the severity of the pruning.

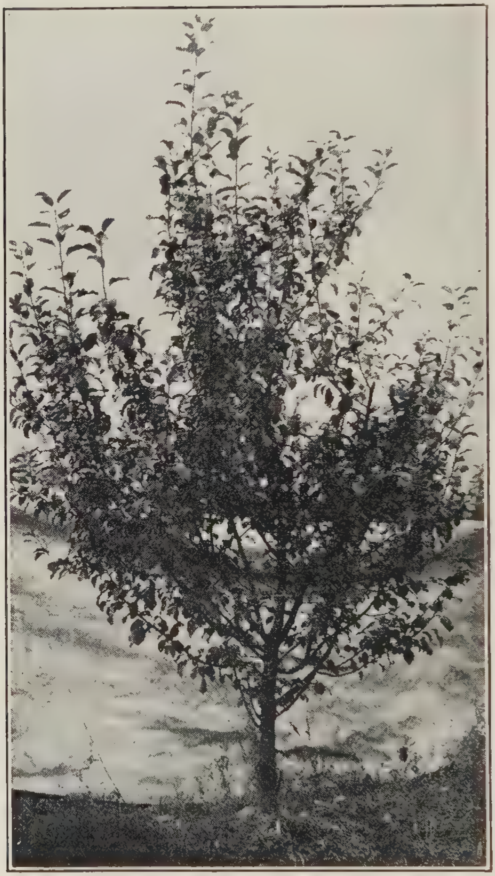


Fig. 22. Wealthy apple tree in its sixth season. Tree narrow upright. It is ten feet tall and about seven feet in spread. Branches well placed. Compare with Fig. 21. No pruning except for fire blight

Grown by author at Geneseo, N. Y.

In California, Climax plum trees when lightly pruned bore about a crate of fruit the third season and two crates the following year, while the heavily pruned trees bore nothing in the third season and but half a crate the following year. Lightly pruned apricot trees produced 20 pounds of fruit the third year and 60 pounds in the fourth year while heavily pruned trees produced practically no crop. In the case of prunes the crop was 10 to 20 pounds per tree in the fourth year on the lightly pruned trees and nothing on the heavily pruned trees. In the case of peaches in California, given little pruning, an average of 2 tons of Lovell peaches were secured per acre, on a ten-acre block, at two years of age and an average of 20 tons per acre from a twenty-acre block of Tuscan Cling peaches at four years after planting. In the case of Bartlett pears an average of three packed boxes per tree on a ten-acre block, when five years planted. These results merely illustrate the statement made that light pruning or no pruning at all tends to cause the trees to come into bearing earlier. At Cornell University, New York, with apples, pears, plums, cherries, in nearly all varieties and irrespective of species, heavy pruning of young trees reduced the total amount of fruit produced. Early bearing tends to stunt the trees as much as severe pruning, but this is not undesirable

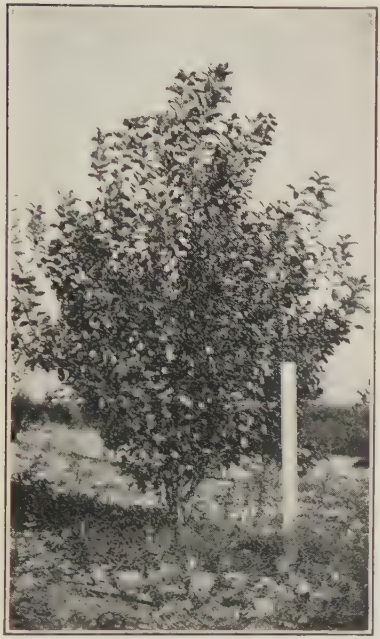


FIG. 23. Young apple tree which received a light annual pruning while dormant. W. Va. Agr. Exp. Sta. The pruning consisted of the removal of unnecessary branches, no heading-back being practiced. Trees so handled grow larger, come into bearing earlier and bear larger crops. Stake 4 feet.

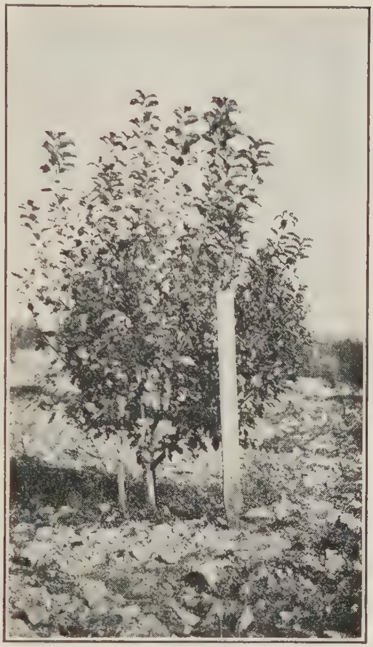


FIG. 24. Young apple tree which received an annual heavy pruning while dormant. W. Va. Agr. Exp. Sta. Heavy pruning consisted of removing three-quarters of the growth the first year, two-thirds the second year, one-half the third year, one-fourth the fifth year, in later years, the branches were thinned, only; pruning time—March or early April. It stunted the tree. Stake 4 feet

since fruit is the object sought and most of our trees soon grow larger than is economically desirable.

Length of trunk. In the coldest parts of Canada the tree should be headed as near the ground as possible, to give adequate protection to the trunk. In the irrigated districts and on the Pacific Coast including British Columbia, the trunk varies from 1½ feet upward to the first limb. In the rest of the apple-growing regions the heads now being formed usually are from 2 or 3 to 5 feet from the ground. In exceptional cases all of the limbs are removed so that a man can stand under the first one. This is the old style high-headed tree.

Low-headed trees bear earlier than high-headed. Trees which are headed low, the first limb at perhaps 20 to 30 inches from the ground and the head formed between this and 4 or 5 feet, will come into bearing much quicker than other trees which are trimmed up and headed with the lowest limb 5 feet from the ground. There does not seem to be any special reason for heading the trees so high as was formerly practiced in the East. The complete removal of the leader from a newly planted tree and the starting of a mass of branches within 6 or 8 inches of space on the trunk is a questionable policy.

The Central leader type of tree. The aim should be to have four or five main limbs at least a foot apart on the trunk and in most varieties a leader. Where sunshine is lacking as in Nova Scotia, where the amount of sunshine for the three months of June, July and August may be less than five hundred hours, somewhat of an open center is desired. As soon as it is determined that sufficient height has been secured the leader may then be headed off in the direction desired. This is practiced with Baldwin and Ben Davis in Nova Scotia.

The open center tree. On the Pacific Coast this type of tree is more frequently met with than in the East. If not carefully handled the tree is apt to tear apart. It is used for the peach.

Varieties need specific treatment. Some varieties, such as Wagener and Oldenburg, tend to load so heavily with fruit that little growth is made after the trees go into bearing and they may need to be stimulated by heavy pruning to make more wood growth. There are conditions which the individual grower will need to study in the handling of each variety.

The ideal tree. There is an ideal tree in the mind of each thinking orchardist toward which his vision leads him. For the younger generation and those in charge of young trees it is not only a grand thing to grasp the vision of the ideal, but also it is essential to know the normal course the tree must take to reach its destiny. A branch leaving the trunk at a wide angle as in McIntosh is stronger than one making a narrow angle as in Northern Spy. Two branches should not arise opposite each other, both are weak. If two exist, stunt one by pruning. Each main branch of a standard tree should have its sphere of influence. No other limbs should encroach. On each branch lesser branches should arise which proceed outward, perhaps alternately on either side of the main branch like the ribs but alternating. The number allowed to live will depend on the length of the branch. They should have ample space, perhaps at least 2 feet apart.

The development of fruit spurs all over the tree should be jealously guarded. Even the main branches may bear them close to the trunk. The main limbs should arise on the trunk at such intervals and at such angles as to make for strong unions. Whether the tree be a pyramid or open-centered or shaped between these two types will depend upon the ideal in mind: there is a place for all.

The ideal may be seldom seen, but it is wise to have one in mind. The world stands aside for the man who knows where he is going. Frequently a single variety is enough for specialization. One is ample to keep a man busy a lifetime in learning how to handle a tree. Marshall of Massachusetts excelled with McIntosh; another man learns how best to handle the Northern Spy, another the Green Newtown, and so it goes.

Pruning to secure shape. In pruning to shape the tree one will aim to cut off a limb at the point where there is a branch growing in the desired direction, hoping that the branch thus left will feel the effect. Frequently however, one finds that some bud lower down on the limb will take up the task of replacing the removed limb. It will be a constant fight between the tree and the orchardist. In ninety cases out of a hundred the tree will win in the attempt to place its branches where it feels they ought to be.

If one has tried to make a spreading tree of a Green Newtown or a Sutton apple tree or of a Beurré d'Anjou pear tree, or to make an upright, growing tree of a Rhode Island Greening or McIntosh apple tree by pruning into shape, he probably gave up in the attempt and conceded to the tree the right to determine its own destiny. This is one case where the right of "self-determination" is usually allowed to have sway. Many of the more studious growers let the tree alone, except to remove small limbs, which they know will not be needed; or if they prune they prune the whole of the tree, trying to suppress that which they desire to suppress by shortening that part more than the rest of the tree. The result, however, is usually the same. The harder the pruning, the harder the tree tries to send out a vigorous shoot to replace the one removed.

Growth is strongest at the tips. It is recognized that growth is always strongest at the tips of the branches. When terminals are cut or pinched back in the summer, growth tends to be strongest just back of the point of pinching or cutting. Its effect may not be apparent very far down upon the branch. Summer pruning may consist of pinching off the top of strongly growing twigs, or the removal of twigs and branches.

Pinching back the tips of shoots upon young trees is regarded as good practice by some growers in Oregon, but does not appear to be good practice in New Jersey, except when trees are growing irregularly and one desires to repress some strong vigorous twig. In West Virginia when summer pruning consisted of thinning out branches of a bearing tree it had little effect upon the growth of the tree. Rubbing the water sprouts out of the center of the tree from time to time during the summer seems to have little effect upon crop production.

In regions where the growing period is short and the winter severe as in Wisconsin, heavy pruning in early summer, say in June or later, is decidedly injurious to young bearing trees. The trees are excited into a late growth and the practice is not advisable. In Minnesota, young apple and plum trees up to twelve years of age can be pruned any time between November and April with satisfactory results. Pruning in May appeared to be less satisfactory, while pruning in June after growth was well advanced seriously checked development. With mature trees the removal of a small amount of wood in June did not seem materially to affect the tree. In New York apple trees severely headed back in October and November suffered seriously from winter injury, while those so pruned the following March suffered but slightly. Pruning reduced the resistance of the tree to cold.

In New York, if done in middle or late summer and the tree is carrying a full load of fruit there may be no suckers formed; if done in June and the tree is carrying a load of fruit, few suckers may result even with vigorous pruning of bearing limbs. The energies of the tree are fully occupied in perfecting the crop of seed. Severe cutting back of one limb of a tree and leaving the rest of the tree unpruned, materially checks the growth of the pruned limb.

Summer pruning non-bearing trees. In California two-year old apricot, cherry, peach, pear, plum (Japanese and European), and prune trees were summer pruned. The results were as follows:

EFFECT OF SUMMER PRUNING ON SIZE OF TRUNK

Treatment	Increase in circumference of trunk (centimeters)
No summer pruning	7.5 (152 trees)
Moderate thinning-out and heading back on May 4	6.5 (252 trees)
Moderate thinning-out and heading back on May 4, and again on July 11	5.2 (96 trees)
Moderate thinning-out and heading back on August 8	5.4 (30 trees, apricot, Cherry, pear only)

Here summer pruning at any time was devitalizing. Cutting back in mid-summer was more weakening than that done earlier in the season. Some pruning may have to be done to shape a young tree but the less cutting done the better for the tree. Rubbing a bud off and thus avoiding the necessity for cutting it off is the better way to train the tree. It may be practiced when planting yearling whips.

Know the tree. One must know the tree before he begins to prune. We prune old peach trees to force them to make a large amount of new wood, because the fruit is borne on new wood. With apples and pears, the fruit is generally borne on spurs usually two or more years old. Once an adequate number of fruit spurs is secured we aim not to spend too much of the tree's energy in growing wood.

Many apples set fruit on one-year-old wood. There are many varieties of apples which bear fruit buds on new wood. These buds are formed the same year the wood is made, as with the peach. This occurrence is quite common with Bismarck, Ben Davis and Gano, and this is the reason why some varieties of apples are annual bearers. One-year-old apple trees in the nursery rows sometimes bear a fine crop of blossoms on Winter Banana, Baldwin, Wealthy, McIntosh, Stayman and Rome Beauty.

The habit of bearing fruit on the previous year's wood is relatively common on apples grown in the arid regions. It is not uncommon in the East and must be considered when pruning the tree; also it must be remembered when one hears that this or that system of pruning induced this habit of fruit bud formation. Thus far there is no record of any summer pruning system inducing earlier bearing than could be secured by leaving the tree alone. A curtailment of the water supply in late summer is a much more efficient producer of fruit buds than is pruning.

Handling Rhode Island Greening trees. Because a young Rhode Island Greening apple tree which has and should have its center left in at all times appears to grow upright (and something like a pole for the first two years) one should not cut the center out of the tree. At four the lateral growth will begin to appear and at six the tree will be of greater spread than it is tall, even if no pruning be given. Any pruning should be for the purpose of keeping a center in the tree and to encourage it to continue heavenward. The same is true of McIntosh and Winter Banana.

Shaping Wealthy and Wagener trees. Wealthy will grow upright so fast that fruitgrowers often fear the trees will be poles before they bear, but if given little pruning they bear early and the trees open up and begin to get spread. Wagener illustrates this very well. At ten years of age the trees begin to develop a spreading habit, having had an upright tendency up to this time. Accordingly one should study the description of the tree and ascertain all he can about its mode of development to know whether there is any occasion to worry or not. Some fruitgrowers are like some parents,—spending years worrying over habits that their children have at different stages of development only later to find that such habits at such times were but the normal expectancy in the course of development.

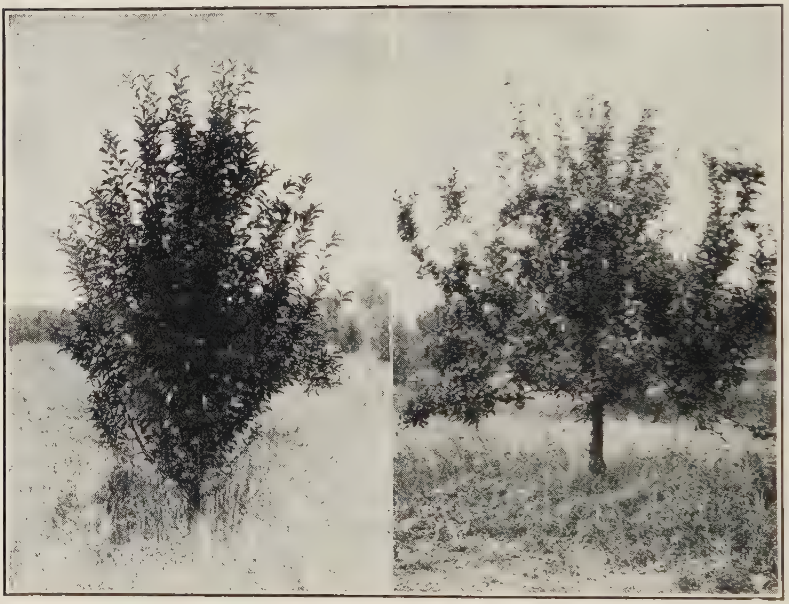


FIG. 25. What three crops did to shape a Wagener Apple tree. The change in appearance was made while little or no pruning was given. The six years planted tree on the left had a height almost double its width, but three years later owing to having borne crops, the appearance was much changed. The width equalled the height. From this time on the trees maintained a more spreading type of growth.

Photos by the author in own orchards, Geneseo, N. Y.

Stick to an established system. Low-headed trees are much less apt to suffer from trunk injuries such as winter injury, than high-headed trees. The branches shade the trunk. There is just one thing to state however in regard to all policies. If a man has successfully worked out a system and knows how to handle that system and is successful with it he should rigidly adhere to his course. Life is too short to learn or try out other ways when the one practiced is already a success. It takes many years to test out anything in fruit growing, probably ten or more; if something new is found to be a failure there is that much time lost. Usually a custom has a reason back of it and that reason should be carefully considered before any change is made.

Reason for European method of pruning. The English gardener had to have a job. Therefore, he winter-pruned, summer-pruned and root-pruned his trees; all eminently proper in a garden where one desires that each specimen shall conform to a certain form, but absolutely impractical where one seeks to make a living from trees. Even in Great Britain the wisdom of their systems of pruning is still a matter of debate with gardeners.

The first question to ask about every operation in regard to a tree is, Will it pay? Pruning should be for a definite purpose. If one does not know what he intends to do or hopes to accomplish, it would be best to keep out of the orchard, especially if the trees are young. One can do a lot of damage in a short time. When the trees get old and it is more difficult to saw off a limb one often gets tired and he asks himself what he seeks to accomplish before doing much.

CHAPTER X

PROBLEMS IN PRUNING

Pruning is a normal process. It goes on every day, on every tree. Just as some people will die today, so some cells in each tree will fail to meet the demands made on them and they will pass off the scene. Go in the woods and see great limbs, dead. Nature has pruned the tree.

A tree is a town of plant cells. Each main limb is like an avenue in a town. The fruit buds on the small branches are units. This fact must be kept in mind when pruning a tree. Each bud is an individual and differs from its neighbor as two brothers may. We remove a main limb from a tree. The limb is diseased; that disease may be carried to the trunk and from the trunk to other limbs (as fire blight is carried in the sap). Pruning thus acts in much the same way that the control of a contagious disease in a city ward benefits the town. A ward of a town might be removed and make no great impression on the rest of the town, but the evidence of the site where the ward stood would still be apparent. Frequently no immediate response may follow the removal of a limb on the rest of the tree, except on the cells near to where the limb was removed.

Dehorning. The most striking illustration of this is seen when we "dehorn" a tree. "Dehorning" consists of reducing the limbs of a tall tree for the purpose of constructing a new head closer to the ground. Frequently 15 or 20 feet are cut off apple trees; in the succeeding years we get a growth of water sprouts on the remaining stubs of the limbs which were cut. The best of these water sprouts should be taken in hand and from them a new head constructed. The danger in this work comes from the fact that the surfaces of the limbs which are cut seldom cover over, and frequently in fifteen or twenty years after "dehorning," heart rots have affected the main limbs and trunk, making the tree useless. The effect of such vigorous pruning is not felt by an unpruned limb except as it benefits by a fuller enjoyment of sunshine. It has its own roots which appear to be concerned with that particular limb and no other, for if there are limbs which are full of fruiting wood and are making little growth and these be left unpruned and the rest of the tree is pruned, suckers do not start on the unpruned limb. The effect of pruning is local.

Spur pruning. Apple and pear trees possessed of fruit spurs and that bear indifferently and that do not make sufficient wood growth may be pruned to stimulate wood growth. But suckers are not desired. The sucker is usually a protest on the part of the tree against abuse; hence the rational policy is to prune the whole tree so that the whole tree may be stimulated. This may be done by going over the tree, removing one-third or a half of the fruit spurs. This causes better vegetative growth but does not induce suckers. In this case we have a system of pruning which affects all parts of the tree, just as though one had improved the standard of a town, not by obliterating all of its slums, but by improving every house in the town.

Why we prune young trees. The main reason for pruning young trees is to shape the tree. At this time the orchardist should have a vision of the tree as it would be when twenty or more years old. This necessitates an intimate acquaintance with the habits and ways of the different varieties of trees, for each variety is different, not only in its fruit but in every other character. That is why it is a variety. If the tree is normally developing there is no sense in pruning it. It is not to be expected that a two- or four- or even a ten-year-old apple tree will have the same shape that it will have at forty any more than one would expect a growing child to have the shape it will have when forty years of age. There is a regular and orderly course of development, normal to the tree and to the child and one needs to know what is normal.

PRUNING THE BEARING TREE

1. *We may prune to bring trees into profitable bearing as in the case of spur pruning.*

Root pruning. In Europe dwarf apple and pear trees are frequently root pruned, one half of the roots of the tree being cut off at 3 or 4 feet from the tree during the month of June to throw the tree into bearing. The same thing is done with the Mango in the Tropics, the aim being to stimulate the formation of fruit buds.

Summer pruning. We may summer prune by merely pinching the tips of the twigs, thus removing the terminal bud; or by shortening in the young shoots to two or three buds to force the fruit buds to set on this wood. This is sometimes practiced with the peach and plum, not so much with the apple and pear as it is in Europe.

Girdling. We may girdle a branch of the tree in June to throw it into bearing. This like most other systems of pruning, tends to weaken the tree; but in the case of the Corinth grape which furnishes the dried currants of commerce, if the vine is not girdled each year at the right time the yield is practically a failure. This annual girdling does not seem to injure the vine. In the case of apples, during June an inch of bark may be taken as a band from the trunk of the tree or the knife may make two or three spiral cuts in the bark of the trunk of the tree, the latter is the safer. It may be safer to do this on half of the branches one year and on the other half the next year. Trees which are too luxuriant may sometimes be thrown into bearing in this way.

2. *We may prune to maintain the tree in regular bearing.*

In the peach, fig and black currant we stimulate the development of a certain amount of new growth each year in order to secure fruit-bearing wood, the fruit buds being produced on wood of the same year's growth. In apples and pears we do not want a superabundance of vegetative wood but need to maintain a good supply of fruit spurs and these are usually formed on wood at least two years old. We may take out surplus wood to give more light to the remaining limbs and to preserve the fruit spurs on them. This may consist of the removal of part of the past season's growth, small twigs. The long bare poles often seen on old trees are generally the result of a lack of sunlight. Too little sunlight favors the development of disease and lessens the growth and development of fruit buds. Adequate terminal growth of the limbs is essential to secure size in the fruit. We may head back a tree to insure this, and in heading back cut to a shoot, do not leave a stub.

Time to prune. It is not advisable to prune frozen wood. Older trees should be pruned first in the winter pruning, younger trees being left until spring. Cuts exposed to very low winter temperatures are apt to die back. This is apt to occur in the Western states. Wounds made in the period of most active growth will heal quicker than those made at any other time, but it is not always convenient to do the work with this one consideration in mind. In some cases as where canker is prevalent we may have a special time to prune, but ordinarily we prune any time of year that we see an error which needs correction, remembering that practically all the growth made by the apple tree before June in the northern fruit belt, is made out of plant food stored in the tree during the previous year and that the function of the tree from that time to fall is to store food in its trunk and roots for use during the following spring.

The philosophy that winter pruning stimulates wood growth is true to this extent—if we remove a limb or limbs at that time, the food stored in the roots and trunk will be used by a less number of branches and the individual growth of such will be greater, but the total wood growth of the tree will be less.

The idea usually held that in summer pruning a luxuriant tree may be made to bear by removing or interfering with some of the plant food elaboration machinery such as its leaves or with the transportation of the food by girdling at the time it is ready to store food, say in July or August, is worthy of mention. According to this view the tree is checked by the treatment. The existing relationship of the carbohydrates to other nutrients is changed and the tree may set to work to develop fruit buds instead of wood buds.

Special pruning and bulk pruning. Pruning should not only stimulate the production of fruit buds but also the maintenance of an adequate number at work each year. This involves special pruning and usually is not attainable by going over the tree in a hit and miss way or "bulk" pruning. Pruning the bearing tree in the business orchard means the care of the small branches and of the shoots and the spurs thereon. The shaping of the tree and the arrangement of the branches is supposed to have been done.

Pruning to save thinning. Pruning may be for the purpose of thinning the fruit on the tree. The removal of small branches may be the best way to accomplish this in years when the crop is very heavy. It may frequently be done in early spring with advantage. It is undoubtedly a good plan to go over each tree each year to see whether any pruning is needed and if so to do it.

Water sprouts not usually an asset. Pruning which causes the growth of water sprouts is not maintaining the proper balance between fruiting wood and vegetative growth. Water sprouts may be of value as makers of vegetative growth, but they are apt to be tardy in coming into bearing and unless needed for reconstruction purposes are not an asset. They make shade. A water sprout or crop of suckers is usually a protest against mistreatment.

Danger in pruning. The tendency is to take out too much wood from one part of the tree at a given time. Taking the same amount from all parts of the tree, thus distributing the influence, would be much more effective. At Cornell University the opening of the heads of young apple trees accompanied by a thinning out of the lower branches greatly reduced the yield of the apple trees and did not improve the quality of the fruit. With citrus the removal of limbs which leave holes in the tree is equally undesirable.

Pruning a neglected orchard. In pruning a neglected orchard all dead wood and diseased limbs can be removed. Frequently this will be sufficient until one gets acquainted with the trees. Often a neglected orchard is too thick, there are too many trees to the acre. The question will arise as to whether it will not be best to remove part of the trees so as to admit sunlight and air. If trees are too thick on the ground do not hesitate to let the sunlight in by removing certain trees before cutting off any branches from the trees that are to remain. It is often better to remove half the trees than to attempt to prune the trees into shape to fit the space, although the latter is being done. It requires skill and judgment.

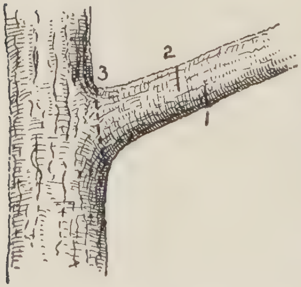


Fig. 26. Showing proper cuts to make in removing a limb. First make the undercut at 1, then at 2, and finally remove the stub at 3. This will avoid tearing the bark off the tree and leave a wound which will heal quickly

Where to begin on old trees. When pruning a big, old tree, first remove all the dead wood; then all diseased wood if it cannot be remedied; and then if more is to be removed prune at the top and gradually work downward, saving the lower limbs.

Removing large limbs. If some limbs are to be removed because the branches are too thick, begin at the top of the tree and work down and save the lower limbs as much as possible. Make all cuts close to the trunk. If large limbs are to be removed make an undercut 2 or 3 inches deep in the limb 15 to 18 inches from the trunk before attempting to saw the limb off. This will prevent the limb tearing off and taking part of the bark off the trunk with it.

Practical reasons for pruning. Pruning should be done when the tree is planted to reduce the number of limbs, removing those which are unnecessary. It may be done when the tree is young to direct it toward a desirable shape, as removing a limb to avoid a crotch or one which is shooting through the center or in the wrong direction; or it may be done to maintain the tree at a certain size and height as in a cordon or espalier tree and sometimes in the commercial orchard. Pruning may be done on a mature tree to thin; to remove bearing wood and thus save hand thinning; to avoid too great a drain on the plant energies; to restrict size; to remove diseased or dead wood, to admit sunlight and to insure adequate terminal growth. When the tree is in leaf, the sun should reach all parts of the tree at some time in the day; if it does not, plan to admit it.

Cost of pruning. In western New York taking the data from 218 orchards for the six years, 1910 to 1915, trees averaging forty years old and 35 to the acre, a man pruned on an average 14 trees in ten hours at a cost per tree of 18 cents; per barrel of 7 cents, and per acre of $6.37. The comparative costs in various regions is shown below:

Average Pruning Cost for Commercial Apple-Growing Areas 1910-15

Locality	Number of orchards	Age of trees	Number of trees per acre	Trees pruned in 10 hours	Hours per acre	Cost	
						per acre	per tree
Western New York	218	40	35	14	31.85	$6.37	$0.182
Wenatchee, Washington	87	11	81	19	40.31	10.08	.124
Yakima, Washington	120	13	74	14	52.55	13.14	.179
Hood River, Oregon	54	12	72	30	24.36	5.48	.076
Western Colorado	125	17	74	14	53.67	18.78	.254

Pruning usually represents about a quarter of all labor expended up to time of harvest, and including the collecting of the brush it usually costs in the above period from 3 cents to 6 cents per bushel of packed fruit.

Thinning. Apples are thinned at various distances, according to the variety. Red apples in which color is desirable, are usually thinned one to a spur. Yellow or green apples in which color is of less importance, may frequently be left (in fact are often left) to two specimens to a certain spur and all of the fruit from others is removed, the idea being that if the spur is not producing fruit, it may bear next year. In this way the spurs bear in alternate years, and not the tree. On the Pacific coast, Winesaps are usually thinned 8 to 12 inches apart because they are not apt to be too large, while some of the varieties which have a tendency to grow over-size are left closer together.

Cost of thinning. In 218 western New York orchards, seasons 1910-15, but 19 per cent of the growers practiced thinning. The cost of the work was $4.63 per acre, the labor required being 23 hours. Frequently it takes four to five hours of labor to get over a tree capable of yielding ten barrels. In Hood River, Oregon, where thinning is a general practice, on 54 orchards the average cost was $5.54 per acre, the labor required being 24.63 hours. In orchards under six acres in size it was 44.75 man hours per acre, more care being taken in the smaller orchards. In Wenatchee the average time required per acre was 53.29 man hours which at a cost of 25 cents per hour totalled $13.32. The practice is general, which is also true in Yakima where the time taken averaged 49.39 hours per acre and the cost was $12.35. These figures convey a good idea of the relative importance attached to the operation in the East and West. With an average yield of 252 bushels per acre in New York the cost of thinning averaged $.0032 per bushel; in other districts the data show the Hood River average yield as 320 bushels or a cost of $.0176 per bushel; Wenatchee, average yield per acre 593 bushels, cost, $.0223 per bushel; Yakima, 432 bushels yield, cost, $.0283 per bushel.

Thinning improves the quality of the fruit and its sale value, tends to maintain more uniform production and decreases the cost of production. At Hood River experiment station six years' results showed that thinning did not overcome the tendency to bear biennial crops, even when the distance apart was tried at 3 to 4, 6 to 7, and 9 to 10 inches. Thinning influenced both the tonnage produced and the size of the fruit. Old trees lacking vigor may be thinned maximum distances; on younger trees the fruits may be left closer, 3 to 4 inches apart is minimum and 9 to 10 is the maximum; 6 to 7 inches proved most profitable. The table on page 109 is the record of four blocks of twelve-year-old Winesap trees in Walla Walla:

The value of thinning this variety to 6 to 7 inches is established at this point. In the East where irrigation is not practiced, thinning during June and July tends to maintain annual

THINNING WINESAP TREES AT WALLA WALLA

Treatment in inches	Yield per tree—Boxes Packed fruit	Culls	Average size of packed fruit	Value of crop
No thinning . . .	4.5	10.25	188	$5.87
Thinned 3-4 . . .	7.75	5.25	175	11.25
Thinned 6-7 . . .	10.	1.75	163	15.65
Thinned 9-10 . . .	9.5	2.00	150	15.12

bearing. But thinning is not a cure-all. It may pay, again it may not. To secure large-sized fruits the fruits must be properly pollinated and the trees must make vigorous growth. If this vigorous growth is lacking the fruit may be undersize even when thinned. In the case of some varieties thinning does not seem to produce the desired effects and it may be wise to take the crop while it is on offer.

How to thin. The best results are secured by thinning as early as possible. It is more easily done. In the West shears are used quite generally. In their use care must be taken not to injure the fruit which is to remain. The points of the shears may easily cause trouble. Hand thinning is now advised. The stem of the apple is held between the thumb and first finger, the apple inside the hand; it is then tapped or pushed off its stalk by the second finger. Holding the stalk prevents the fruit spur from being pulled off; with the apple gone the stalk dries up and later falls off.

Propping. Propping the tree often is necessary to prevent the limbs from breaking. In many instances the cost of propping is equal to that of pruning. Different methods of propping are in use. In the West is seen the most systematic work. Board props may be used, 1x2 inches or 1x3 inches, from 8 to 14 feet long. Propping may start in July. The props may need resetting two or three times during the summer and autumn. The average amount of labor required for propping in Hood River was 14.23 man hours and 13.56 horse hours per acre. The props had to be hauled in and out of the orchard each year. At 25 cents an hour for the man and $5.50 per day for man and team, a cost of $5.65 per acre was entailed for labor and team. The average cost in Wenatchee at the same time was $6.36 per acre for propping, the number of man hours required varying from 13.85 to 21.17; horse hours from 3.58 to 27.68, so that the cost varied from $5 to $7.61 per acre. Putting screw eyes into the limbs and using wires from same to a central band near the center of the tree is growing in favor. It saves the work of moving the props annually and leaves the land clear.

The cost of propping under eastern conditions is no greater than in the West. The usual method is to support the limbs by placing stout poles under them. In case of heavy crops it may be necessary to use a large number of props, especially when the trees are high-headed. In many of the more recently planted low-headed orchards the limbs come down to the ground and the upper limbs rest on them.

CHAPTER XI

POLLINATION

In most of our fruits we find male and female blossoms on the same plant. Frequently, the pollen of the plant is capable of fertilizing the ovule and insuring seed production and fruit. We are on the threshold of many important discoveries in pollination problems. The data available is frequently of but local application, and generalizations are not warranted.

Some flowers are female. This is true with certain varieties of strawberries, grapes, dewberries and many other fruits. Some plants are female only, as in the date, and the pollen essential to cause the fruits to set must be furnished by a male plant, usually planted nearby.

Catkins and walnuts. In the walnut, and in fact in most of the nuts, the male or pollen-bearing catkins appear separate and distinct from the female blossoms which become the nuts. The common agency for transferring the pollen is the wind. Franquette walnuts produce very few catkins until seven to ten years old and consequently set few fruits while young. They appear to overcome this difficulty when they get older. The planting of Wiltz or Sturgis Mayette or some other good variety with Franquette is good practice. The Du Chilly Filbert whose catkins bloom a month later than Barcelona can pollenize the Barcelona since the stigmas are not receptive when the pollen of the Barcelona is ready to blow, but Barcelona cannot pollenize Du Chilly and to insure nuts on bushes of this variety we need Clackamas, Turkish or Daviana plants in the grove. In some of the Pecans the female or pistillate flowers are mature before the staminate or pollen-bearing flowers are open, and vice versa; and in both cases we have sterility. It is possible that something like this may happen in certain varieties of apples.

Seedless fruit. Some varieties of orange, lemon and pomelo are capable of forming fruits without pollination. Most of the seedless varieties are seedless on this account. The Washington navel orange not only has no pollen but it is only in a few regions that its ovules are capable of fertilization with any pollen.

Influence of location on sterility. The Bartlett pear is sterile to its own pollen in Maryland but usually not in western New York; Kieffer needs a pollenizer in New Jersey to insure a crop, but generally this does not appear to be true in New York. Pears will not produce fruits unless pollination is a success. A plant may be capable of pollenizing itself in one region but not in another. Napoleon, Lambert and Bing sweet cherries are not only sterile to their own pollen but are inter-sterile in Oregon. This does not seem to be true in New York. In Oregon, Waterhouse seems to be one of the best pollenizers for Napoleon (Royal Ann). Many plums are sterile and can be pollenized only by certain varieties. Some of the dewberries need another variety to insure a supply of pollen and a crop of fruit. Many varieties of grapes need another variety alongside as a pollenizer.

Apples and pears frequently self-sterile. Self-sterility is a common condition with apples and pears. At Ottawa, Canada many varieties of apples are self-sterile or practically so, and need pollen of another variety to insure a setting of fruit. With apples it is believed by some that the stamens which bear the pollen mature more quickly in high temperatures than the pistil; hence pollen of a variety may be shed before the stigma is ready. The reverse is also true. In other cases the temperature does not go high enough to energize sufficiently the pollen so that it may reach the ovary in time. The slow growth of the pollen tube in cold weather is probably a common cause of sterility in plums.

Sterility among apples. Among the varieties of apples which show weakness in pollination are Ben Davis and Winesap in certain regions as for instance in the Ozark region. In Illinois it is reported that these varieties are sterile; Williams Red also has the reputation of carrying a profuse bloom, and setting little fruit. In Oregon it is claimed that both Esopus Spitzenburg and Winesap fail to produce pollen and there is difficulty with these varieties. It would be useless to plant them together even though they bloom at the same time. They do not produce pollen. The very low yields of apples secured in the Ozark region is sometimes credited to the fact that most of the area planted is set to Ben Davis and Gano; these are in solid blocks and are incapable of pollenizing each other or themselves. In the Ozarks, Grimes Golden and Jonathan are both regarded as good pollenizers for Ben Davis; they are varieties suitable for the locality.

In western New York, Rhode Island Greening and McIntosh need a pollenizer.

Varieties vary markedly. Ralls (Geniton) is stated to be self-sterile in Oregon where it comes into bloom with most of the varieties, while in the Ozarks it pollenizes itself, and is one of the last varieties to come into bloom. Thus we may go on. Nothing can be taken for granted. It must be proven. Loss of crops may come from the wrong varieties having been planted together. Failure may be due to a trifle.

A typical flower. A typical plant is illustrated by the orange blossom. It contains the scaly protective covering called the *calyx;* the white petals which constitute the *corolla* which are believed to be for the purpose of attracting the insects. Then we find the *stamens* or pollen-bearing organs which are the male portion of the plant, and in the center are the female organs with the stigmas exposed, the sticky gum on their surface placed there to catch the pollen and below them the *ovary* with its embryos, some of which are capable of being fertilized by the material from the pollen grains.

The method of crossing. If the pollen applied to the stigma be known and care is taken to apply it before any other has access to it, the resulting cross will be one whose parentage is known. To accomplish this the stamens are removed from the flower before the pollen is ready for distribution. The flower is covered if need be until the stigma shows the sticky gum on its surface. Then the pollen from the desired variety is brought, usually in a glass vial, and it is applied to the surface. No brush is used in this case although it is sometimes with other plants. The plant is now enclosed in a bag to prevent the entrance of other pollen, the tag bearing the record is attached and the plant is left covered until the fruit is set. In this way new varieties of known parentage are secured. Carefully recorded data are revealing to us that certain varieties of fruits when crossed by certain other varieties are much more likely to give offspring of value than can be secured by pursuing a hit and miss policy.

Desirable parents. Professor Macoun of the Ottawa station, Canada, reports that Northern Spy, Wealthy and McIntosh apples have exceptional power in influencing the character of their seedling offspring; that half of the seedlings of McIntosh are worth keeping; that bright red apples nearly always produce red-fruited seedlings; that if the female parents are poor in quality no high quality seedlings need be expected. Seedlings of Winesap have poor roots, while those of Ben Davis have good roots. McIntosh and Tolman Sweet seedlings have good roots.

Conditions affecting pollination. Rain, cold and wind are all unfavorable conditions at the time of bloom. Warmth and sunshine are favorable. Temperature is probably the most important factor.

Rain. Rain washes the pollen from the anthers. (Some authorities question this.) Rain washes away the secretion from the stigma or so dilutes it that the pollen fails to germinate. An excess of moisture may cause the pollen sacs to burst. In many fruits the pollen will not germinate in water, but this is not always so. During periods of warm rains the pollen may germinate while still in the anthers, before being shed. Rain prevents bees and other insects from transferring the pollen. Cold weather does the same because the bees do not like to fly when the temperature is below 50° F. Most of the pollination of apples is accomplished by bees and other insects. If they cannot work, fertilization is not likely to be effected and the crop will be poor.

Bees are of value. The value of bees was proven in West Virginia. Sixteen trees were taken in each of two blocks, practically equal in bloom. Branches of apple blossoms of another variety were set in pails of water in the trees to furnish pollen. Six hives of bees were allowed to work in one block but not in the other. Where the bees worked 12.6 per cent of the bloom set, where they did not 7.8 per cent set. The yield from the trees fertilized by the bees was 174 bushels, that from the check 83 bushels.

The gain is due in the main to the cross fertilization secured, but the bees were the agents that carried the pollen. It is worthy of note that the bees are not interested in the pollen, they want the nectar, and in the variety of plum, Denniston's Superb, which blossoms carry a high percentage of nectar, the bees work these trees so well that they pollenize the tree thoroughly and it is regarded as a good bearer on this account. Even if we have two varieties planted close together, unless there is something to induce the bees to pass from one block to the other we may fail to get the results and the relationship of varieties to each other as pollenizing agents is worthy of much more serious study. Plants have affinities. Apples have affinities. Some varieties yield good crops when pollenized with pollen from certain varieties, but fail to set fruit when others are used.

An apple blossom has five stigmas. Each one must receive the fertilizing material from a pollen grain if a normal apple crop is to result. Unfertilized or partially fertilized apples when they persist to harvest time are deficient in size.

Temperature. The most favorable temperature for the germination and development of the pollen grain of the apple in Wisconsin appears to be 75.2° F. In Iowa 72 to 77° F. Anywhere between 69.8 and 73.6° F. appeared to be most satisfactory at Ottawa. In Oregon between 65 and 83° F. was found to be satisfactory. In West Virginia at a temperature of 80 to 90° F. in the daytime, fertilization of Rome Beauty apples was accomplished in 24 hours, while at lower temperatures it took 90 to 120 hours, or failed. In Canada at 40 to 43° F., the pollen tubes would but partially develop.

Favorable climatic conditions may cause a variety which is usually self-sterile to fertilize itself. Present indications are that in the Rome Beauty self sterility is due to the fact that the pollen tube grows too slowly to reach the embryo in time; the pollen itself is viable. While apple pollen appears to withstand freezing without injury, its germination is retarded by temperatures lower than those indicated. Hence, it will be seen that not only do we want freedom from excessive moisture, but that bright, sunny weather is desirable and fairly warm weather. These are relative terms, the suitable degree of heat varies somewhat in different localities. Exceedingly warm weather with hot dry winds is generally undesirable. Thus temperatures ranging from 86 to 94° F. while apples were in bloom were not conducive to the setting of a good crop of fruit in one locality but were not undesirable in West Virginia for Rome Beauty. A temperature of 25 to 27° F. may be fatal to the flowers when in full bloom. After fertilization has taken place the flowers may endure 28 or 29° F. for a short time.

Length of time apple blossoms are open. Apple blossoms do not all open at the same time on the same tree. Sometimes the bloom will last a week if conditions are favorable and the weather is warm and dry. If unfavorable, the blossoms may persist two weeks waiting the coming of a favorable day for fertilization.

Influence of nitrate of soda on the set of blossoms. At the Oregon station the application of 7 pounds of nitrate of soda per apple tree a month before the trees came into bloom on a soil lacking in humus and nitrogen caused Yellow Newtown trees to set 166 per cent more fruit and Esopus Spitzenburg 87 per cent more than was set by those not so treated. The conditions were favorable for the fertilizer being carried to the roots quickly. The soil was light and the blossom buds were weak. Under such conditions nitrate of soda applied one to two months before bloom is of value. An adequate supply of plant food, especially nitrogen, either stored in the tree or available for use, and water are essential to secure a satisfactory set of fruit. On strongly growing trees, fertilization may be effected in three or four days less time than on trees making a weak growth.

Position of the bloom. A blossom located on a strong vigorous shoot or fruit spur has much more chance of becoming an apple than has one located on a weak shoot. Fruit spurs through which there is the greatest flow of sap set the largest number of fruits. Weak fruit buds, even when they set, fail to mature their fruit which is another good reason for keeping the foliage of the tree healthy and vigorous so that strong fruit spurs may be matured.

Weight of 88 Fruit Spurs on a Baldwin Branch

30 spurs which held their fruit less than two weeks averaged 2.94 grams each.
28 spurs which held their fruit until the June drop averaged 3.29 grams each.
30 spurs which held their fruit after the June drop averaged 4.27 grams each.

Fruit Spurs Bearing Six Flowers to a Cluster are Better Than Four Flowers

Of 266 Baldwin spurs each bearing six blooms, 54.9 per cent bore fruit.
Of 137 Baldwin spurs each bearing five blooms, 40.9 per cent bore fruit.
Of 50 Baldwin spurs each bearing four blooms, 20.0 per cent bore fruit.

There is no wisdom in growing large strong fruit spurs, capable of handling large amounts of water, unless they are provided with an abundant supply of moisture when the tree is in bloom and setting fruit. This is another way of saying that early and thorough cultivation and proper spraying or the equivalent are necessary to secure the benefit of the previous year's work.

Position of bloom to size and shape of fruit. The position of the bloom in the cluster has an influence upon the shape of the apple and the length of the stem. This varies with the variety. Investigations in Montana show that the central flower sets a short-stemmed apple. In the variety Arkansas, the fruit is larger and more uniform than other fruit set by the side blossoms. In Wealthy, the fruit borne by the central blossom is better in shape and appearance, matures better and stands up better in storage than that grown by side blossoms. In McIntosh the central blossom produces fruit quite variable in shape and undesirable, while that borne by the blossoms on the outside of the whorl of flowers is apt to be flat, and that borne by the blooms between the two is the best commercially. In thinning, therefore, this factor is worthy of investigation and consideration.

Influence of cross-pollination on number of seeds. Fruit which is cross-fertilized may be expected to have more seeds and generally speaking when seeds are not set the fruit fails to make proper size. The influence of pollination on seed formation in apples in West Virginia is shown below:

	Seeds per apple
Rome Beauty, selfed (i.e., self fertilized)	3.50
Rome Beauty, crossed	7.10
York Imperial, selfed	2.70
York Imperial, crossed	7.00
Wagener, selfed	1.06
Wagener, crossed	6.88

Cross-pollination on set of fruit. In West Virginia varieties differ in the percentage of blossoms which set fruit, and the percentage set is small as is seen below:

13,129 blooms Rome Beauty self-fertilized set 162 fruits or 1.23 per cent.
3,697 blooms Rome Beauty x Rome Beauty (pollen from another tree, same variety) set 6 fruits or .16 per cent.
16,645 blooms York Imperial self-fertilized set 94 fruits or 0.56 per cent.
5,097 blooms York Imperial x York Imperial (pollen from another tree) set 35 fruits or .68 per cent.
2,563 blooms Wagener self-fertilized set 31 fruits or 1.20 per cent.
844 blooms Wagener x Wagener (pollen from another tree) set 12 fruits or 1.40 per cent.

When left to do what they could in a mixed orchard the results were as follows:

10,676 blooms Rome Beauty set 472 fruits or 4.46 per cent.
15,992 blooms York Imperial set 1,260 fruits or 7.87 per cent.
5,315 blooms Wagener set 455 fruits or 8.50 per cent.

Rome Beauty does not normally set as much bloom as York Imperial or Wagener under these conditions. Hence in judging the value of cross-pollination it is essential that one knows the normal set of the variety.

From the table on page 118, it will be seen that while Ben Davis gave only 2.43 per cent set when used to pollenize Rome Beauty, and 6.33 per cent when used to pollenize York Imperial, it was about as efficient in one case as the other. The same thing is brought out when Wagener is used as the pollenizer.

1,029 blooms Rome Beauty x Ben Davis set 29 fruits or 2.43 per cent.
1,326 blooms York Imperial x Ben Davis set 84 fruits or 6.33 per cent.
1,074 blooms Rome Beauty x Wagener set 35 fruits or 3.25 per cent.
2,572 blooms York Imperial x Wagener set 294 fruits or 11.43 per cent.

Benefits of cross-pollination. In Maine, out of 119 varieties, but 15 set a commercial crop of fruit when self-pollinated. In Rome Beauty in West Virginia the percentage of set was increased 350 per cent, that of York Imperial was increased 1400 per cent and that of Wagener 700 per cent by cross-pollination.

BENEFITS OF CROSS-POLLINATION IN SET OF FRUIT

	Number of bloom	Fruit set	Per cent set
Rome Beauty not crossed . .	16,826	168	.99
Rome Beauty crossed	20,587	702	3.41
York Imperial not crossed . .	21,742	129	.59
York Imperial crossed . . .	25,775	2137	8.29
Wagener not crossed . . .	3,407	43	1.26
Wagener crossed	6,993	611	8.73

Influence of cross-pollination on size of fruit in apples. From time to time it is remarked that the pollen of one variety causes fruit to grow larger than the pollen of another. With apples and pears it appears to be almost universally true that fruit which is cross-fertilized is larger than that which is self-fertilized. There is good correlation between the weight of the individual apple and the weight of the seeds.

In corn, Xenia occurs; the pollen has a marked influence not only upon the offspring but upon the characters of the kernel of corn, changing the color of the seed coat even, but this does not appear to be true of apples.

In West Virginia it has been shown that not only does cross-pollination of Rome Beauty and York Imperial insure a better setting of fruit but in accordance with previous observation a marked increase in the size of the fruit is seen.

INFLUENCE OF CROSS-POLLINATION ON SIZE OF FRUITS

Rome Beauty x Rome Beauty gave fruits averaging 3.67 ounces each.
Rome Beauty x York Imperial gave fruits averaging 5.18 ounces each.
Rome Beauty x Wagener gave fruits averaging 4.93 ounces each.
York Imperial x York Imperial gave fruits averaging 3.32 ounces each.
York imperial x Rome Beauty gave fruits averaging 4.66 ounces each.
York Imperial x Wagener gave fruits averaging 4.62 ounces each.
York Imperial x Ben Davis gave fruits averaging 3.82 ounces each.
Wagener x Wagener gave fruits averaging 5.43 ounces each.
Wagener x Rome Beauty gave fruits averaging 3.77 ounces each.
Wagener x York Imperial gave fruits averaging 3.94 ounces each.

Rome Beauty crossed by the two varieties named insured a gain of 27.8 per cent in size. York Imperial crossed by the two varieties insured a gain of 42.7 per cent in size. Rome and York Imperial may have been too good as pollenizers for Wagener in this case, setting more fruit than the tree could grow into good sized fruits. If a tree is bearing a very large number of apples, they are apt to be smaller in size. They should be thinned.

Plan to secure cross-pollination. Cross-pollination appears to be advisable in apples. It is apparent that it is advisable to have varieties in the orchard which bloom not only at the same time, but which can pollenize each other. In some seasons if there is one row in four of a variety which blooms somewhat later it may furnish pollen for the flowers which are tardy in opening or which have not had opportunity to be fertilized owing to conditions. If a variety is planted purely as a pollenizer, probably 4 per cent, or one in 25 is the minimum. It is better to have four rows of one variety and two rows of another variety, or four and four alternately. When a pollenizer is necessary four rows are usually the maximum width for a block. A lack of pollen is noticed after the second row is passed.

Time of bloom. The time at which a variety blooms is important. Some varieties and certain early blooming fruits are apt to be caught by spring frosts. The grower should ascertain the probable time of bloom and select late blooming varieties for frosty locations, and select the most favorable location for early blooming varieties. The time of bloom varies with the season. It may be early or late. There may be all of a month's variation in the time of bloom of the same apple tree in different seasons. Varieties vary also in their relative time of bloom, one variety may bloom early one year and be late another, while one which was late may bloom early and on a third occasion all may be in bloom together. The problem then of finding suitable pollenizers is not simple. It is a matter of determination in each locality for a term of years. The records of fruit-testing stations which conduct this work should be studied as well as those of local growers.

In southern climates the tendency is for the flowers to open before the leaves start, further north leaf and bloom tend to start together. The amount of heat the plant receives from January 1 determines the conditions of growth at any given time to an important extent, and each variety has a different heat requirement. Soil, moisture, light and other factors also enter into the question. Incidentally, early bloom induced by frost injury may indicate a pathological condition and is correlated with low production. In the Northern states along the Great Lakes, the relative order of coming into bloom of various fruits is approximately as follows: Apricot, sweet cherry, pear, plums, red currants may come out first. Apples, sour cherries, hybrid cherries, gooseberries, peaches, crab apples follow in three to six days. Strawberries may be two weeks later, blackberries, dewberries and raspberries a month later, and grapes are last, often six weeks later than the first group.

CHAPTER XII

WHAT CAUSES A TREE TO BE FRUITFUL?

Our knowledge regarding this and many other fundamentals regarding plants is fragmentary. Our ideas and methods will change as the principles underlying plant growth and development are revealed.

Apart from the inherent characters of the tree itself, it is now recognized that the production of fruit buds accompanies certain relationships between several factors. Of those of most importance are the water supply and the plant food taken up by the roots, principally the nitrates together with the starches, sugars and allied substances which are manufactured by the leaves. Adequate leaf surface is fundamental.

The research of Kraus and Kraybill indicate that when the factors of water and food are in proper balance, the tree forms fruit buds regularly. Heat and light of course are necessary to stimulate proper activity of the cells of the plant. Thus far, four general conditions have been recognized in regard to the relationship between the nitrates, carbohydrates and the water supply in the plants. These are:

(A) No available carbohydrate supply. When there is available an abundant supply of moisture and mineral elements from the soil, but no stored and available carbohydrate supply the plant is unfruitful.

1. In a young tree, there is no reserve of starch and cellulose, and bearing does not begin until this condition is attained.
2. If the foliage is destroyed, it does not matter how much plant food is in the soil. Starch formation cannot go on without leaves. The starch is made by the leaves and until it is made, the tree will remain unfruitful; hence, we spray to protect foliage. Starch is not stored far distant from the leaves which elaborated it. A weak or scanty growth of leaves on a shoot will be unable to form a fruit bud. A strong growth of leaves and a short fat spur growth will insure a strong fruit bud.
3. The removal of a large portion of the foliage of a tree by summer pruning may so weaken the tree by preventing the formation of starch that it may be rendered unfruitful. Summer pruning may be so devitalizing that it may take several years for the tree to recover. The premature removal of the leaves does not stimulate fruit production; it inhibits fruit bud formation.

(B) An abundance of moisture and mineral nutrients and nitrates, coupled with an available carbohydrate supply, makes for increased vegetation, barrenness and sterility. In this case, everything is abundant, there is a plethora of food. It is seen in the cherry transported to Ceylon. The tree becomes an evergreen and never bears fruit. Oats grown in Cuba do not trouble to form seed. Peaches planted on too rich land are notoriously unproductive. There is great development of the vegetative parts and little attention is given to the formation of the reproductive parts. This condition may be affected to a degree by the available supply of light.

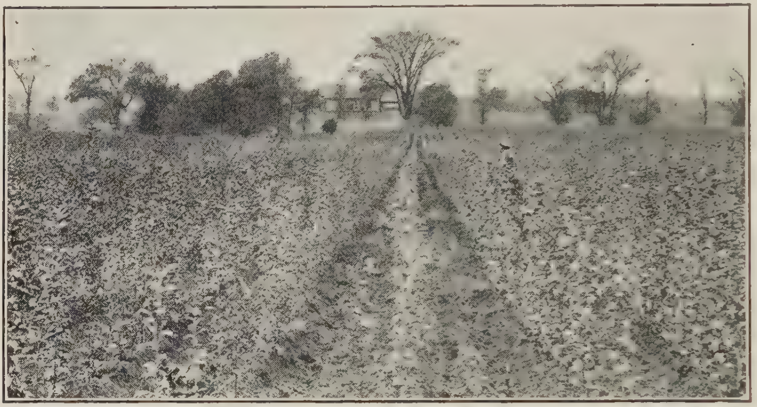


FIG. 27. A scene in one of our nurseries showing a fine block of yearling apple trees. One probable reason why these young trees do not set fruit buds is that they have little reserve starch or other carbohydrates; they illustrate condition (A)

Photo at Geneseo, N. Y..

(C) A relative decrease in the nitrates in proportion to the carbohydrates makes for an accumulation of the latter—and also for fruitfulness, fertility and lessened vegetation. As compared with condition (b), we have less growth, but apparently a balance between growth of the vegetative and the reproductive organs.

Trees must make some growth each year. In the East, apple growers desire that the twigs on the main limbs shall make at least a foot of wood growth each year. This insures an ample supply of leaf-bearing wood to elaborate the carbohydrates which are essential for the formation of fruit buds for the ensuing year and to mature the crop. This balance may be upset by injudicious pruning, or over-feeding the orchard, but is more apt to be upset by lack of care, as neglect of spraying to protect the foliage or tillage to conserve the water supply. Once this condition is secured in an orchard the grower should strive to maintain it. Moderate and regular pruning, will probably best assure this favorable condition. In the case of mature trees, the stimulation of new wood growth may be secured by giving heavier pruning to all parts of the tree.

(D) A further reduction of nitrates, with a possible increase in the carbohydrate content of the plant. This makes for a suppression of both fruit-bearing wood and of vegetative growth. This is seen in old trees, trees on poor soils, trees on dry soils, trees which are partially girdled or injured. The trees carry foliage which is weak, yellow and small. They may bloom profusely but set no fruit. The remedy for this condition is:

1. Remove half the fruit spurs. The tree needs pruning all over on every branch.
2. Cultivate and conserve moisture.
3. Apply water to dry soils.
4. Apply nitrates to the soil.

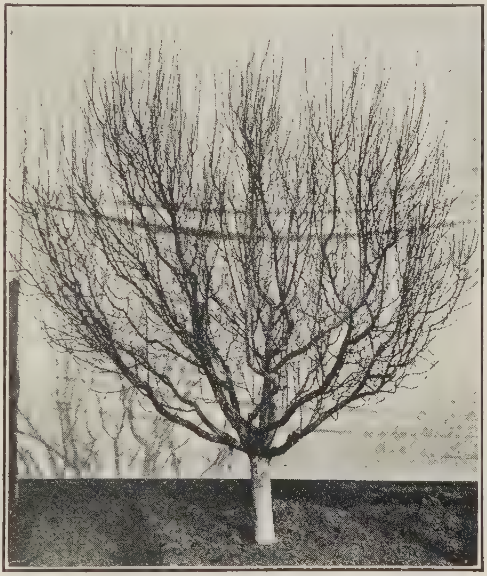


FIG. 28. Condition in (B). This tree is making too much wood growth. To prune it more will merely stimulate more wood. One of these branches is no older than the fruit spurs shown in Fig. 30

The tree is probably on soil which is too rich and it has been over-pruned.

This is an open-center tree, a head not desirable for eastern conditions. All limbs have a common starting-point, they are not well placed

To check growth and induce bearing, sow to grass, cease cultivation, reduce the water supply. Utah Agr. Exp. Sta.

It is under conditions like these that the application of nitrate of soda or nitrogen in some other available form as sulphate of ammonia, cyanamid, calcium nitrate, etc., to trees gives

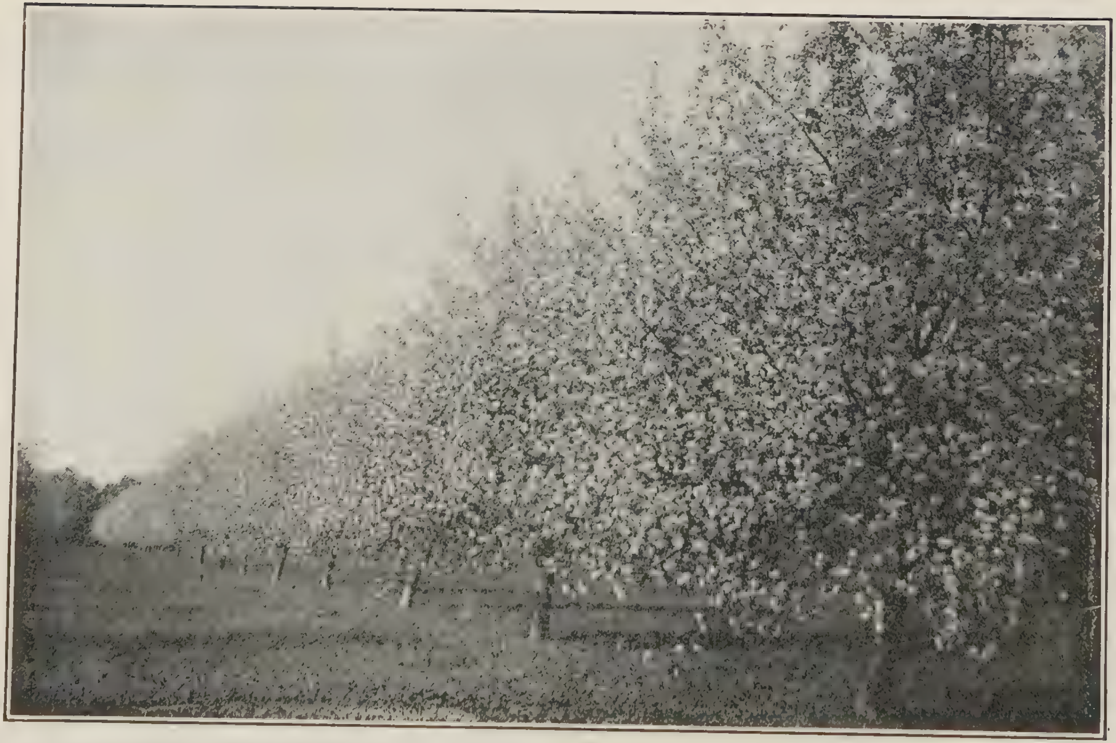


Fig. 29. To illustrate condition (C). A block of Ben Davis apples coming into good bearing, owned by C. W. Catchpole, N. Rose, N. Y. The trees have not been excessively pruned. Wood has been left in them in which they could store a reserve of starch and they have gone into bearing in marked contrast to Fig. 28. Young orchards may be encouraged to bear fruit by allowing the cover crop to remain for a year

such remarkable increases in crop yields. The condition of the trees may be such that they are but slightly removed from that of (c) and the addition of relatively small amounts of nitrogenous fertilizer is sufficient to restore the balance with marked profit to the owner.

Old trees are apt to get into this condition due to neglect of the fruit spurs. Fruit spurs have a life. As they get older they lose in vigor and set less fruit. Spurs on heavy branches have more vigor than those on thinner branches. The spur is the tree barometer. One must secure a certain amount of new wood each year, to secure new spurs. Young trees which have just come into good bearing, produce handsome fruit because they are full of strong shoots bearing vigorous spurs.

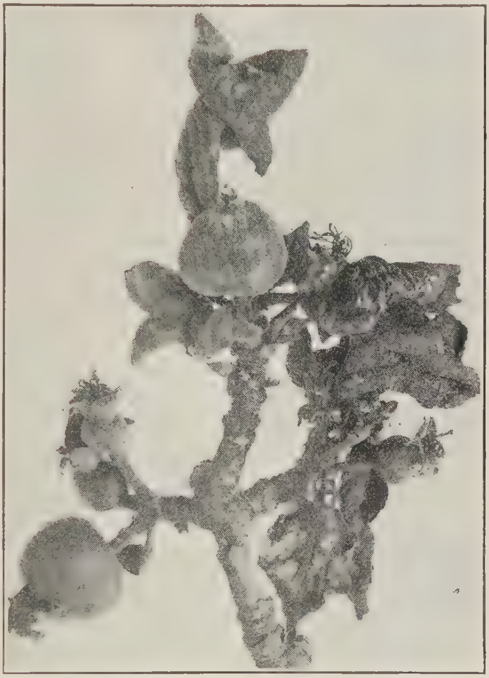


FIG. 30. This fruit spur shows condition (D), and in addition to being lacking in vigor it has been completely stunted by the Rosy Aphis. The apples will persist. Trees in this condition are worse than worthless. They take the space and energy from some other crop *U. S. D. A.*

Some points to remember are:

1. Fruit buds will not form in most varieties in the absence of an adequate amount of leaf surface in the tree.
2. Leaf surface in one part of the tree will not furnish food material to buds in another part of the tree. If half of a tree be left unsprayed for one or two years and the other half is kept sprayed, this will be apparent.
3. Food material stored in the tree is stored relatively near where growth is to occur. In twigs it is stored in the tissue adjacent to the leaves in which it was manufactured.
4. Fruit buds on wood which has been defoliated prematurely are much weaker than are those on wood which held its foliage. Such fruit buds may be so weak that they fail to grow.
5. A mechanical injury to the bark on the trunk of a healthy tree may greatly stimulate fruit bud formation. The nitrates move from the

roots to the leaves through the inner bark and the elaborated carbohydrates are returned to the growing parts through other cells in the bark. If the bark is injured or the tree girdled the upward movement of the nitrates and the flow of the elaborated carbohydrates from the leaves to the roots is checked and as a consequence the percentage of carbohydrates in the top of the tree is increased. Increasing the proportion of carbohydrates tends to stimulate the production of fruit buds.

6. With our young trees for the first five or six years we stimulate vegetative growth, and prune to give the tree shape or not at all if the tree is growing satisfactorily. We try to maintain condition (b).

From five to 10 years of age, we aim to encourage the formation of carbohydrates in the tree and discourage excessive growth rich in nitrates. This is done by avoiding excessive cultivation, by seeding the orchard to grass for a year in the East, and by avoiding the removal of large amounts of wood rich in carbohydrates. Trees of this age should not be overpruned. The idea is to let them get into bearing and then as they go on to get them into condition (c) and maintain them there.

Effect of light. A fruit is of the highest quality when grown at the most northern or most southern latitude at which it will mature; in other words, at the greatest distance from the equator, or where it receives the optimum amount of light in conjunction with all the other factors which are essential for growth. The same appears to be true of mankind. The highest degree of civilization and the highest type of mankind is found at the most northern latitude at which mankind may conveniently live.

Some plants will not come into bloom when grown near the equator, but will bloom and bear fruit when grown further north or south of the equator. Something controls the time of bloom and the ripening of the fruit and the presence or absence of light is believed to be a prime factor and to be of more importance than heat. It has long been recognized that something more than heat is involved in getting high color in apples; in fact cool weather is essential to secure color.

At the equator, the day never exceeds 12 hours duration. In Alaska, it lasts twenty hours sometimes, and even though the snow be on the ground, vegetation grows with amazing rapidity. Just as the large amount of light stimulates vegetative growth, so the restriction of light or the attainment of a certain degree of light appears to control the production of bloom and the maturation of fruit. The conception of this fact gives increasing significance to the wonderful power which was liberated when the order was given, "Let there be light!"

The power of light can be illustrated by the ragweed. The ragweed requires the longest days we have in New York to cause it to grow vegetatively. It does not attempt to form bloom until the period of daylight falls below 15 hours out of 24. In the latitude of Washington, D. C., this occurs about July 1; in northern Maine it would occur about August 1. Northern Maine has ample light to grow the plants; they grow, but there is not sufficient time between August 1 and the time of killing frost to enable the plant to mature seed, so the ragweed cannot live in northern Maine.

The migration of the birds may have a similar basis. The ratio of light to darkness is proper to furnish sexual activity during spring in the northern regions and the birds migrate. In the fruit tree, fruit buds do not form on the branches which are densely shaded. Light must be admitted to stimulate sexual activity as well as to elaborate food products.

Flowering and fruiting period under control. Garner and Allard of the United States Bureau of Plant Industry state that under greenhouse conditions the flowering and fruiting period of practically any plant can be made to take place at any time of the year by darkening the greenhouse in the morning and evening if the day is too long, or by lengthening the day by artificial light if the day is too short. Spring flowers come in the spring because the days at that season have the proper number of hours of daylight, and the maturation of fruits is under similar control.

When the length of the day is favorable to both sexual reproduction and vegetative growth, we have the "everbearing" condition. This is seen with peaches and apples in parts of the tropics and with many other plants, such as oranges and lemons, in which we find fruiting and bloom and vegetative growth going on continuously.

The requirements of each variety of fruit and the amounts of light available in a locality will when determined, give us knowledge regarding one more factor in the production of American fruits. One seemingly serious obstacle to the acceptance of many plausible statements is that they do not appear to meet all of the facts. For instance a number of plants have been grown in a uniform artificial light for their entire existence, and produced seed, which appeared to be just as good seed as that grown in the presence of sunlight. But light itself is an important factor.

Formation of flower buds. Experimental work in Iowa with Jonathan and Grimes Golden apples showed that the formation of fruit buds is affected by the management the orchard receives, and that the amount of soil moisture present is a most important factor. Trees grown in sod in which the soil moisture content was lower than under tillage formed their fruit buds earlier in the season. On trees in sod the formation of fruit buds began about July 1, while on trees under tillage the fruit bud formation continued until September 15, a period of two and one-half months. The time taken by a single tree for the formation of fruit buds was usually about four weeks. The time taken to form and develop a flower was in some cases ten months, the fruit bud being formed July 1, 1916, and the period of full bloom May 17, 1917. From the time of formation of the fruit bud to harvesting the mature fruit was a period of fifteen months.

Time of growth of the flower. The apple flower appears to have two periods of rapid growth. The first is when the flower bud is being differentiated from the leaf bud. This is usually a period of about four to six weeks, in which the floral organs are differentiated. The second is the following spring. a period of about six to seven weeks, in the above instance beginning about six weeks prior to the opening of the flower and ending with the period of full bloom in which time the floral organs increase their size many times. In the interval between these two periods of rapid development, growth is continuous but slow.

Life of a fruit spur. As a result of experiments in Missouri, the evidence seems to show conclusively that in many of our leading commercial apples, a good fruit spur is not usually able to mature fruit and at the same time develop a fruiting bud for the following year. Occasionally we find a fruit spur which will produce blossoms two years in succession. In West Virginia it was found that spurs which blossom two years in succession make a greater yearly growth, have more leaves, and a greater total leaf area in the year preceding the second successive blooming year. Thus it appears that growth and vigor to a certain degree do not oppose but rather encourage fruitfulness. In Missouri, varieties such as Gano, Rome and York, which tend to produce crops in alternate years in certain localities, do so because in their fruiting year practically all of their individual fruit spurs are bearing fruit and there are very few non-fruiting spurs. On the other hand, varieties such as Jonathan and Winesap, grown under similar conditions, would produce annual crops because only a portion of their fruit spurs set fruit in any given year.

Some varieties which bear fruit annually, form fruit buds terminally and laterally on one-year-old growths to such an extent that the fruit borne on this young wood is often enough to class the variety as an annual bearer without regard to its fruit spurs.

The indications are that an individual fruit spur has a fruiting life of from two to eight years. Few spurs may begin to bear before they are three years old and few retain their bearing form beyond six years of age. When they reach this age, if conditions are favorable, a spur will develop into a longer branch and upon this a new crop of fruit spurs will develop. It is very important for the fruitgrower to recognize; (a) that it is essential for the fruit spurs to receive the stimulus of light to induce them to maintain a fruiting condition; and (b) the question of annual or biennial bearing is largely one of control of the fruit spurs. Removal of the blossoms from a tree, either by accident or design, may result in a change in its fruit-bearing year. The removal of the blossoms or the removal of the fruit on an individual fruit spur or branch, provided it is done early enough in the season, may also aid in bringing about this change. Of course, the securing of a crop of fruit is dependent upon other factors in addition to these as pollination, etc.

Fruit spurs of high-headed and low-headed trees. Trees which are pruned to a low head will develop more fruit spurs than high-headed trees of the same age, grown alongside. It appears that the longer stems and branches not only tend to dry out during the winter but they tend to restrict the proper flow of sap; in other words, the further the branches are from the roots, the less desirable the condition. In short-trunk trees, there is less restriction to the passage of the sap, for this reason the spur development is better and the succession of fruit spurs can more easily be secured. The sap from bearing spurs is of a somewhat higher concentration and has a lower freezing point during a considerable portion of the year than sap from non-bearing spurs. Sugar and starch are present in somewhat greater degree in bearing spurs than in non-bearing spurs. If the blossom or fruit is removed from a bearing spur, this sugar is apparently available and is utilized toward the formation of a fruit bud for the following year.

Effects of fertilizers on fruit spurs. In Missouri, a test extending over several years showed that nitrogen is an important factor in the production of fruit spurs. Trees which had been heavily fertilized with nitrogen established a stand of fruit spurs while no such fruit spur development was found on check trees, or on those which were fed with mineral salts. The indications are that under such Missouri conditions, as prevailed in this case, a supply of nitrogen is very essential in the development of the strength and vigor and size of young apple trees, and it hastens the development of bearing habits.

Type of wood growth. When trees make a growth of average length but slender, such growths are usually unfruitful. Long growths (even watersprouts) which are thickened by an excessive carbohydrate supply may be quite fruitful. To secure annual crops an adequate vegetative growth must be maintained. Good, strong terminal growths 10 to 12 inches in length with perhaps 18 to 20 inches on the leading branches are almost always essential to insure annual production. In the case of Wealthy apples when a terminal growth of less than 10 inches is made the trees are biennial in bearing, when 20 per cent or more of the terminals on the main and lateral limbs made a strong growth of 10 to 20 inches annual crops were secured; open-topped trees, those which admit sunlight freely, are more fruitful than dense-topped trees.

CHAPTER XIII

FERTILIZERS

The work of the Pennsylvania station indicates that for eastern conditions, good results follow the application of fertilizers to orchards after the fruit crop is set. The best fertilizer can be ascertained by test only, by determining the kinds of fertilizer to which the trees respond, and using these until they cease to give any increase in yield. In other words, the fertilizers which prove of benefit for one decade may not be of value for a succeeding period. Fertilizers must be distributed over all the root-feeding area, and well beyond the spread of the branches. Nitrate of soda and other fertilizers applied to one side of a tree will be used by the roots and branches on that side only. Water taken up by the roots on one side of a tree may pass through all parts, but this is not true of fertilizers. The result from fertilizers is local.

Sod orchards. Fertilizers which give marked returns when applied to apple orchards in sod and those deficient in organic matter may not give any increase of returns if the orchards are cultivated and cover crops are grown. The fertilizers which benefit grass and trees, as nitrate of soda frequently does, may not be of value to trees alone. A large acreage of American apple orchards are in sod and on such the use of nitrate of soda may be profitable. Sulphate of ammonia may be used to furnish nitrogen, but it is not so quickly available, and if leguminous cover crops are to be grown it is suggested to apply a ton of lime per acre for each ton of sulphate of ammonia used. Kainit and basic slag may be applied in the previous fall because they are relatively slow-acting. Acid phosphate and nitrate of soda are usually applied after the blossoms have set and we know we have a fruit crop. In delaying the application to this date due consideration must be given to the differences in vitality of trees.

Fertilizers needed to aid bloom. In one instance in Ohio, it was found to be beneficial to apply the fertilizer in April, rather than in May, but this was on land in poor condition and from the results it seems that a nitrogenous fertilizer was necessary to enable the fruit buds to set fruit. In this case the application of the nitrate of soda two or three weeks previous to the time the blossom buds came out was of benefit. It should be stated that in this instance a rain followed the application, which rendered it quickly available so that the results were apparent the current year. Similar results were secured in Oregon. An application of nitrate of soda at this time is proving of value in other places. Generally the effects of fertilizers on apples and other fruit trees will be more apparent the succeeding year than in the current year, because the fruit buds for the succeeding year are made the year before.

Trees in poor condition. Usually trees which have a yellowish or scanty foliage or those on soils which fail to produce good cover crops will profit by the application of a fertilizer containing nitrogen as nitrate of soda and the effect may be apparent in two weeks after the application is made. Heinicke at Cornell University found that an application of nitrate of soda increased the nitrate content of the sap in the bark of apple trees within twenty-four hours after application. Nitrate of soda is frequently used on peaches in order to aid the trees over a dry period, and it is of marked benefit for this purpose. Care must be taken not to overdo it, otherwise the fruit will not ship well. This is also true of apples. The use of nitrate of soda tends to delay maturity and may delay the ripening of peaches from three to five days or even ten days, and apples longer.

Effect on size of crop. Generally speaking, fertilizers have more influence in increasing the total amount of fruit and foliage than in increasing the size of the fruit. Apples induced by the application of fertilizers are apt to consist of a large number of undersize specimens. Stated in another way, under eastern conditions heavy crops induced by the application of fertilizers are apt to be of less than average size. We are apt to set more apples than we have water for; hence the advantage of the man who has irrigation. An adequate supply of moisture must be available and the fruit properly thinned to maintain size. We need size to meet modern market requirements. To secure it we must not have too many apples on the tree. We must thin if necessary. At the Virginia station thus far the moisture content of the soil has had more influence upon the formation of fruit buds than fertilizers.

Thus far no correlation has been determined between the composition of the soil and its fertilizer requirements. In some cases even on relatively poor soils no kind of fertilization has given profitable returns. The problem is a strictly local one. Each orchard is a problem of its own.

Nitrogenous fertilizers. In Pennsylvania, in a ten-year experiment on five out of six orchards, the use of nitrogen had a marked effect upon both the yield and the growth of the trees, and the beneficial effects of the fertilizer have shown no signs of abatement at the end of the period. In two instances with nitrate of soda at $100 per ton the increased yield of fruit is stated to have cost less than 9 cents a bushel on the tree. Nitrogen from commercial sources or from stable manure has proven more effective than that from cover crops.

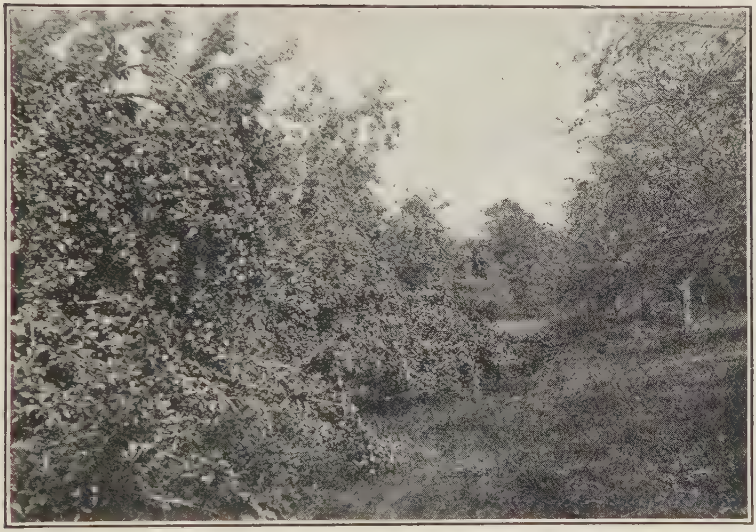


FIG. 31. Nitrate of Soda and Phosphates *versus* nothing in a Pennsylvania sod orchard

Courtesy Pa. Agr. Exp. Sta.

The use of nitrate of soda and manure tends to delay the maturation of the fruit. Fruit on trees which carry heavy foliage is apt to show less color; hence the indiscriminate use of nitrogenous fertilizers cannot be recommended where a long-season apple such as York Imperial is grown in a short season locality, or where it is short of color. Nitrate of soda has shown advantages over other forms of nitrogenous fertilizer, especially when a quick-acting fertilizer was desired. In Ohio and Oregon marked benefits were secured from an application of nitrate of soda very soon after the buds started in spring and before the blossoms opened. In light soils on the Pacific Coast there is frequently a lack of nitrogen and the use of nitrate of soda not only aids the setting of the fruit, but also increases the size of the crop. It should be applied early. It enables trees to better withstand frost but it should be remembered that the use of nitrogenous fertilizers can be easily over done. Sulphate of ammonia contains about 24 per cent of ammonia while nitrate of soda contains nitrogen equivalent to 19 per cent of ammonia. The nitrogen in nitrate of soda is immediately available for plant use. That in the sulphate of ammonia is usually not so quickly available. If the soil is warm, the ammonia of the sulphate of ammonia may be converted into a nitrate, the form in which the plants generally use it, in ten to fourteen days after application, if cold the change does not take place until the soil gets warmer.

Amount of nitrogen recovered by the plant. At the New Jersey station the experiments conducted for twenty years show that with field crops the average recovery of nitrogen applied in the form of nitrate of soda was 37 per cent, and of organic nitrogen 26.5 per cent. The higher recovery of the nitrate nitrogen is probably due to the fact that it is immediately available and it gives the plant a good start. On account of the rapid growth secured, the plant is able to utilize the nitrogen more fully than is possible when nitrogen in the form of organic matter is supplied. Under the most favorable conditions 60 per cent of the nitrogen applied in the form of a nitrate has been recovered in the crop grown. Nitrogen applied in the form of a nitrate stood first in yield of dry matter and percentage of nitrogen recovered in the crop on various loam soils, and on sandy loams, except those which consisted of 80 per cent or more of sand.

Phosphates and potash. In Pennsylvania, neither phosphates, potash, nor lime when used alone had any influence on the yield or growth of apples, but all may be of indirect value to cover crops. Acid phosphate appears to be somewhat more efficient as a carrier of phosphorus than other phosphatic fertilizers.

Present status. Taking a number of the experiments in the United States, we have somewhat the following status:

New York: An experiment has been running for twenty years at Geneva, N. Y., on a heavy clay-loam soil. The orchard was cultivated and non-leguminous cover crops grown. The gains made from applications of fertilizers did not pay for the cost of application. In another experiment, on an orchard cultivated for twelve years, not enough increase was secured to pay for the cost of application. In another orchard in sod, nitrate of soda gave a marked increase in yield. But on part of the same orchard which was kept under cultivation and cover crops, no increase was secured.

At Cornell University with young apple trees on Dunkirk clay-loam soil nitrate of soda was of value to trees in sod but under a system of cultivation and cover crops the addition of nitrate of soda was not of value, even when applied at the rate of 900 pounds and even 1,800 pounds per acre.

New Jersey: Minor gains are reported from the use of nitrogen, potash and phosphorus.

Pennsylvania: Apple trees standing in a non-legume sod must receive nitrogenous fertilizers. Dried blood, nitrate of soda and other nitrogenous fertilizers proved as beneficial as manure. Orchards in sod and not receiving fertilization or other aid are usually a failure. In some orchards trees mulched with 150 pounds of straw per tree plus nitrogenous fertilizers were as productive as those receiving tillage. The straw mulch harbors mice. Tillage without a cover crop depleted the soil fertility so much that to save the trees, a change of treatment was necessary. The growing of a cover crop is advised. On some orchards which were tilled and which grew cover crops, fertilizers failed to return their cost.

West Virginia: On an old bearing orchard, on a soil low in fertility, the use of nitrogen gave substantial gains, while the use of phosphates and potash gave but slight increases. The orchard was under cultivation and cover crops were grown. With younger trees on a richer soil, there were no gains from any fertilizer treatment. With young-bearing trees in a starved condition the annual growth made was as follows: no fertilizer, 3.59 inches; 1 pound nitrate of soda per tree, 8.52 inches; 2 pounds nitrate of soda per tree, 9.71 inches; 3 pounds nitrate of soda per tree, 11.59 inches; 4 pounds nitrate of soda per tree, 14.22 inches; and 6 pounds nitrate of soda per tree, 17.75 inches. In this we have almost a pathological case. The trees were starved and the leaves were yellowish, small and weak. The nitrate of soda produced a more healthy dark-green foliage. Taking all in all, Alderman of this station, states that in West Virginia it is only the exceptionally weakened or starved orchard which requires fertilizing when given cultivation and cover crops.

New Hampshire: Gourley states that the fertilized plats have failed to respond to their treatment with suitable yields of fruit. The unfertilized cultivated plats maintained themselves well for the first ten years, but are now beginning to show signs of exhaustion, so that the time may come when fertilizers will be desirable. On the unfertilized sod plats, the growth made was not sufficient to justify allowing the land to remain in orchard.

Massachusetts: An experiment in a sod orchard is reported to show benefits from the use of manure, phosphates and potash, but after seeing the plats, their variability in soil and water supply, I am satisfied they are not sufficiently uniform to justify any deductions being drawn from them.

Maine: Fertilizer experiments running several years show no beneficial results.

Ohio: The benefits obtainable from the use of nitrate of soda on half-starved sod orchards in southern and southeastern Ohio were marked. Applications of 5 pounds per tree have given 450 per cent increase in yield. The use of phosphates tends to improve the herbage, making a better sod mulch, but potash gave no returns.

Indiana: A ten-year experiment is reported. No beneficial results were secured.

Illinois: The use of nitrogenous fertilizers gave somewhat increased yield.

Missouri: Nitrogenous fertilizers improved the growth and formation of fruit buds.

Montana: Where the trees have been starved by following a system of clean cultivation, beneficial results are now secured by growing clover in the orchards and plowing once in three years. Irrigation is practiced.

Oregon: In some places, soil exhaustion due to constant tillage and no cover crops starved and devitalized the trees to such an extent that they showed marked appreciation of an application of nitrate of soda, especially when applied before the blossoms opened and growth started. Some yields were increased 10 to 24 times. Applications made for two consecutive years showed a residual effect for the next two years. Potash and phosphates were not needed.

There is a certain degree of uniformity running through all these trials and the following appear to be correct deductions:

(a) That starved trees are usually in need of nitrogen.

(b) That trees kept in sod may be starved. The same may be true of those given cultivation without cover crops.

(c) That nitrogen can be furnished by growing leguminous crops or applying fertilizers containing it.

(d) That on rich soils of satisfactory depth for the roots of the trees, that is, good apple soils, if tillage and the annual growth of a good cover crop be maintained, there is seldom need of fertilizers.

(e) If apple trees are bearing poor crops, a spring application of some quickly available nitrogenous fertilizer will frequently increase the yield. Increases in yield may be secured if similar applications be made to trees already bearing fair or even good crops. These increases in yield are due to increases in the set of fruit, and fruit setting is but one phase of fruit formation. If the fruit buds have not been formed on the tree the season previous it follows that no matter how favorable the conditions at time of bloom no crop will result. Recent results indicate that if poor crops are due to lack of formation of fruit buds, then applications of quickly available nitrogenous fertilizers early in spring may only accentuate the trouble.

(f) The use of fertilizers to correct the alternate bearing habit of certain trees is one problem, and is quite distinct from the use of fertilizers to cause the set of bloom.

(g) To use fertilizers intelligently one must be able to diagnose the trouble and make the treatment to fit the case. There is no rule which will meet all conditions.

The financial consideration. In a survey made of 218 western New York farms in 1910 to 1915, it was found that 93 per cent of the men made a practice of applying manure to their orchards. Twenty-nine per cent manured the orchard annually, 25 per cent manured a portion of it and 22 per cent manured the entire orchard every other year.

INFLUENCE OF MANURE ON YIELD OF APPLES

In western New York	Tons per year 5 and under	5 to 9	over 9
Number of records	29	12	5
Tons of manure per acre	3.62	6.92	12.8
Yield (barrels)	82.7	89.4	99.5

The average cost per acre for 133 orchards was $3.81 for labor and $15.93 for material of nine tons or a total cost per acre of $19.74 or 23 cents per barrel. A man and two horses with a spreader applying nine tons per acre covered nearly two acres in ten hours.

Dividing the orchards into three groups we find the following:

Years 1910 to 1915	Group 1 Manure 44 records	Group 2 Manure and cover crop 60 records	Group 3 Manure, fertilizer and cover crop. 38 records
Yield per acre, barrels,	85.8	85.6	86.4
Value of orchard per acre	$434.00	$532.00	$543.00
Total net cost of production per acre	113.69	125.64	133.54
Total net cost of production per barrel	1.33	1.47	1.55
Returns per acre	188.76	188.32	190.08
Net returns per acre	75.07	62.68	56.54

The differences in cost are due to differences in the valuation of land and buildings, the cost of manure, fertilizer, spraying material and in the time spent in pruning, cultivating and spraying. It is evident that the individual should question every item of expense, asking whether it will pay. The highest average yield 104.9 barrels per acre, was from 13 orchards in Group 2 which were tilled, manured and sown to a leguminous cover crop. The cost of production was $143.85 per acre, or $1.37 per barrel. The average net return was $86.93 per acre, the highest net return from orchards regularly tilled. Eleven orchards were in sod. Their average yield was 77 barrels per acre. The total net cost of production on these orchards was $82 per acre or $1.06 per barrel. The net returns were $87.62 per acre, the highest in the series, due to the low cost of operation.

CHAPTER XIV

SOD OR TILLAGE IN THE APPLE ORCHARD

In the principal apple belts of the Northeast portion of the United States, grass and trees are two of the most common crops. The region is both a natural grass and a natural tree country. Laws are enacted compelling the farmers to cut the young trees and brush along the highway and mow the grass and weeds. This is in marked contrast to certain areas in the West, which have been planted to apples and where irrigation is practiced. There the land naturally grows sage brush or desert plants, and if grass grows it is apt to come up in bunches. The humid regions along the Pacific Coast are a grass and tree country as in the East.

Cultivation of orchards was introduced as a means to conserve moisture, although the principal benefit derived in eastern orchards from cultivation is probably the resulting increase in the supply of nitrates in the soil. The practice was early recognized in the West. It was, therefore, from the western men that the eastern commercial orchardists learned to cultivate. Previous to that time the tendency was to plant the orchard and allow it to take care of itself. The custom was followed to a considerable extent in parts of Europe, but there and in the East the results secured under cultivation have caused a reversal of policy and now many of the eastern orchardists maintain as clean cultivation as is practiced in the West. The advised practice today is clean cultivation and cover crops in many but not all commercial orchards. The custom is to plow late in the fall or to spring plow, get the cover crops or weeds turned under as soon as possible and maintain clean cultivation until July or August; then seed the orchard to a cover crop or let the weeds grow. The cover crop is allowed to grow during the fall, principally to furnish humus and also to take up any excess moisture which might tend to start late growth in the orchard. Start cultivation early, before buds and blossoms appear. The decaying weeds stimulate bacterial action and encourage the formation of nitrates in the soil. Strong twig growth and large-sized fruits are made by a strong vigorous start in spring. If the cover crop is scanty an application of a nitrogenous fertilizer may be beneficial. A tree insufficiently supplied with nitrogen requires more water than one well supplied.

Sod mulch. In various parts of the East, certain individuals make a success of apple-growing without cultivation. There are locations where this is a matter of necessity. In the Ohio orchard of U. T. Cox, there is a variation of several hundred feet in altitude in the orchard of only a few acres. It is simply impossible to cultivate the land. The loss which would follow from washing would be so serious as to be practically prohibitive. In such orchards, one sometimes finds the sprayer clamped to a stone-boat. The New York orchard of Grant Hitchings affords another illustration. This orchard is well supplied with moisture from springs. An adequate supply trickles down the hillsides. At Harper's Ferry, Virginia, orchards are planted on the steep hillsides, but the rainfall is at least 50 inches a year; whereas in parts of western New York there is less than 30 inches and in parts of the West but 15 inches. Pennsylvania enjoys

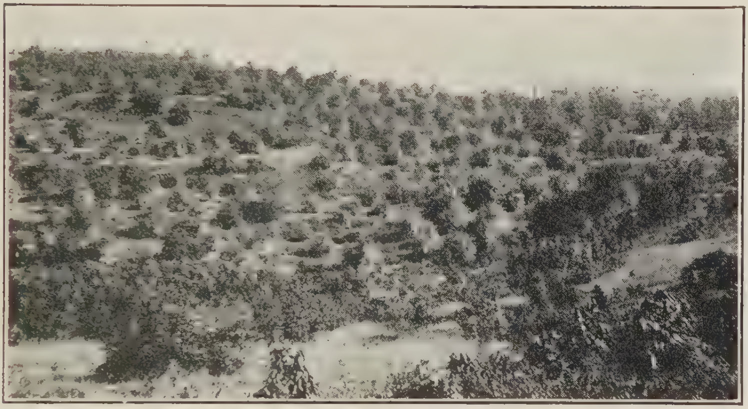


FIG. 32. Apple orchard of U. T. Cox, Proctorville, Ohio. In this twelve-acre orchard there is a difference in elevation of over 300 feet between the high and low points. Naturally it must be kept in sod. It was planted by Mr. Cox's father. When a tree dies another is planted nearby. No alignment is maintained. On orchards like this in Southern Ohio a complete fertilizer is profitable and nitrogen in an available form is beneficial. Note the large amount of space given to each tree. This is essential to secure large sized fruit of high color. Trees are usually planted too close together. Papaws are in the foreground

about 45 inches of rainfall and many successful commercial orchards are in sod.

About 16 acre-inches of available water are adequate for apple trees. In a 30-inch rainfall, at least half is lost by run-off. All men who have made a success in growing apples have conserved as much moisture as possible. either by tillage or sod-mulch methods or by enriching the soil solution by applying fertilizers so that less water is required. The sod-mulch men aim so to enrich the soil with organic matter that it may become a veritable sponge. They grow grass to make a carpet, and one which requires the minimum amount of water. The usual advice is to grow Kentucky blue grass, others prefer alfalfa or sweet clover. Careful analyses show that the cultivation of the soil and the growing of cover crops enrich the soil in organic matter to just as high a point as the growing of sod. Hence. the men who are cultivating and growing cover crops need to have no fear that they are not doing all that is possible.

Sod mulch practice. In orchards where grass is mown and piled round the trees and where grass is cut in other fields and hauled in on them, the nitrogen content can be brought up to a certain point only. When that point is reached, nature finds ways to get rid of the excess. Organisms in the soil liberate the nitrogen into the air. There is an optimum above which it is not wise to go. It is important to see that as much as possible of the nitrogen which is liberated shall go into the plant and not be lost. On natural grass-land in the East, there is little loss of nitrogen even when applied as nitrate of soda. If not used it is quickly changed into an insoluble and stable form.

Grant Hitchings in New York and Vergon in Ohio, ascribe their success to the fact that the sod has never been broken in their orchards. The land was good pasture for years before the orchards were planted. Small holes were made, in which the trees were planted. The grass was mown from time to time and piled around the trees, the area mulched extending as the trees grew in size. Nothing but apples has ever been taken from the orchards. In some instances the grass grown has not been sufficient to mulch the land, even when the trees were small. Alfalfa and other crops have been grown on land adjacent and hauled into the orchards. In the experiments of Professor Stewart in Pennsylvania, he found it necessary to haul three or four tons of additional material per acre to furnish a mulch. In both the Ohio and the Pennsylvania experiments, where sod-mulch appears to have given good returns, it is important to remember that it is not grass land but sod-mulch with the addition of outside material as mulch. A light mulch did little good. The growth made by the trees is in proportion to the mulch applied, and the yield of fruit has gone hand in hand with the growth made, and in almost all cases where grass is grown applications of nitrogenous fertilizers are beneficial.

The final question frequently resolves itself into one of expense. If there is an adequate supply of mulching material on the farm (hay or straw for which there is no other use) the mulching of the orchard may be a possibility, but in those regions where there is no mulching material available, tillage may be a matter of necessity if one would profit by the orchard. Professor Stewart found that alfalfa and hairy vetch were good crops to grow in the orchards, provided they were mown and placed around the trees. Sweet clover has proven very satisfactory in some places, even in peach orchards. In an orchard in which alfalfa was grown, the growth made by the trees was very good. Sherman Morse, near Naples, N. Y., has grown a young apple orchard with alfalfa between the trees, which he cuts for hay. Under his conditions, the trees have made an adequate growth and the hay has paid all operating cost and left a credit. If it is a matter of a man making his living while he grows the orchard, he must resort to some such expedient. If the owner has abundant capital and can devote the land wholly to the trees for the first decade, that is another matter. Today labor difficulties are severe and all farmers put as much land to grass as possible in order to reduce the number of horses and men. Mr. Morse, with one team and one man, has taken care of 100 acres of young apple orchard. Even in Hood River orchards mulching is practiced, although it involves little difference in the cost of production.

Advantages of sod-mulch. In sod orchards spraying is more easily done than in cultivated orchards. With a good cushion of hay under the trees, fruit is not apt to be injured when it falls off; and if one is in close proximity to a market almost all of these windfalls can be sold as good fruit if sent to the market daily. Such fruit is usually high in color, which is usually true of all sod-grown fruit. Even if the yield is lower the cost of production may be sufficiently low to make this system profitable.

Economics of the question. It is not the man who secures the highest yield per acre who will necessarily make the most money; it is the one who can grow apples at the lowest cost per bushel, especially if he has enough bushels. In the Eastern states, land is not high in price, but labor is expensive. Acres are still cheap and sunshine costs nothing. The only way to reckon profits is by the return on the capital and labor invested. The man who can grow apples at 10 cents a bushel and sell at 75 cents and deliver them to his customers with his own truck cannot fail. He is entitled to stick to the method he knows. The factor of variety has probably been too little considered. At Cornell University with McIntosh apple trees, cultivation and cover crops produced a many-branched round-headed tree, while sod-grown trees even when invigorated by nitrate of soda showed a small spindling growth. On the Marshall orchards in Massachusetts, McIntosh is grown in sod most successfully, but the orchard is heavily manured.

System used on sandy soils in Atlantic Coast states. In New Jersey, Delaware, eastern Maryland there is no talk of sod-mulch. Tillage is necessary, especially on the sandy soils. Some of the men without much capital have developed successful orchards by growing cultivated catch crops—berries, corn, potatoes and various other crops between the trees. These men cultivate intensively. The seasons enable them to put in cover crops after the truck crops, either vetch, crimson clover or cow peas, and so to rotate these that they secure an income and grow the trees under a system of constant tillage and cover crops.

System in New York commercial orchards. The methods adopted by the best growers in New York are probably best shown by a summary of a survey made in orchards in Niagara and Orleans counties. The orchards which have been given cultivation and cover crops for ten years or more produced the highest revenues as well as the highest yields.

Dangers attending sod-mulch. Apart from the danger of fire running through a sod orchard there are several features which need consideration. The men who cultivate most vigorously are also apt to spray most intelligently. In other words, the orchards which have been tilled ten years or more in Niagara and Orleans counties, N. Y., are probably those which had better care in other respects. The danger attending the sod treatment, as it is conducted in the East, is in the fact that it is not a sod-mulch, but usually only the growing of grass among the trees. The men expect to mulch the orchard, but the mulch soon degenerates into a plain case of sod; then when the orchard begins to decline in production and the grower begins to prune the expense account there is a marked tendency to omit spraying the year the orchard is not bearing and to reduce the number of sprayings the year it does bear. The result is unsatisfactory. There are great dangers attending the pursuit of the cheap and easy way.

Indian experiences. Experiments at Pusa, India, show that with limes, lemons, oranges, pomelos, plums, custard apples, loquats, peaches, guavas and figs, the trees grown in grass soon assume a pitiable condition, and in the case of the custard apples, loquats, lemons, some of the trees died. All the young trees when grown in grass had sparse, yellowish foliage and made little growth, and in the case of the trees which survived this treatment, they were later in coming into bloom and into leaf and the crop borne was smaller in size of fruit, and the fruit was poorer in flavor. Clean cultivation and the growing of cover crops during the rainy season seemed to be the best mode of management in this portion of India.

Some items of cost. In the Auchter orchard near Rochester, N. Y., the annual cost of cultivating four to seven times during the years 1904 to 1913 was $7.39 per acre; for the decade 1914 to 1923; it cost $14.40. The work was hired done at an average of 45 cents an hour for man and team for the first decade and 60 cents for the second. The cost of mowing the grass on another acre alongside was 80 cents. Grant Hitchings gives his cost of mowing sod as 72 cents per acre per year. In some tests made on his place, the cost of giving nine cultivations to an orchard during the season varied from $11.22 to $24.33 per acre, thus bringing out the important fact that the cost of cultivating an orchard will vary markedly with the soil. the conditions and the season. The average cost of growing an apple crop in the Auchter orchard for the years 1903 to 1913 was $51.73 under sod (no mulch being applied, merely the grass being cut) and $83.48 under tillage, the difference in favor of sod being $31.75. The average annual yield for the ten years from the orchard in sod not mulched, except what grew on it, was 69.16 barrels per acre; and from the acreage under cultivation 116.8 barrels per acre, the difference in favor of the tilled portion being 47.65 barrels per acre. The average annual net return per acre from sod was $74.31; net return per acre from tillage $140.67, increase in favor of tillage $66.36.

For every dollar taken from the trees in sod, after deducting the cost of production and harvesting, the trees under cultivation gave $1.89. The use of nitrate of soda on the trees which were kept in sod was beneficial, but not sufficiently so to bring the production up to that of the trees under cultivation. The fruit from the trees under sod was more highly colored and matured from one to three weeks earlier than that grown under cultivation. The fruit grown under cultivation will keep two to four weeks longer than that grown under sod.

As reported by Hedrick, it was found that under certain conditions, grass injures apple trees in several ways, and these frequently act together. For instance:

1. It may lower the water supply; this is not always true;
2. It decreases some elements in the food supply, especially the nitrates;
3. It reduces the amount of humus;
4. It lowers the temperature of the soil;
5. It diminishes the supply of air in the soil;
6. It has an injurious effect upon the beneficial organisms in the soil;
7. Grass forms a toxic compound which affects the trees.

Sod is less harmful in certain soils than it is in others. Sod may be used advantageously to bring an orchard into bearing when growing too luxuriantly. There may be a dual effect—it may draw not only on the food supply, but also on the water supply, so that when trees are growing too vigorously, it may be worth while to put the orchard in sod for one or two years.

Sod may reduce beneficial organisms. The multiplication of beneficial organisms in the soil often is reduced by the presence of certain crops. On the other hand, the use of other crops may stimulate their production. This has an important effect upon the fruit crop produced. Thus far, it appears that with practically all crops, the effect of grass is to reduce the beneficial flora in the soil.

Injury from toxic compounds. The toxic compounds formed by grass in orchards have been carefully investigated by Spencer E. Pickering at Woburn, England. This interesting work indicated that under certain conditions and on certain soils, toxic substances are one of the chief, if not the chief factor, in causing the sterility and poor condition of apple orchards in sod. In most ingenious ways he has shown that if opportunity be given for the toxic compounds to be oxidized so that their toxicity is lost, the same effect does not result. This may explain why less serious results occur in deep soils in which there is good aeration and where the roots of the trees can get away from the roots of the grass, than in shallow soils. It may explain also why in well-watered soils, as those of Grant Hitchings in New York, the running water may remove the injurious substances from the feeding roots of the trees; also it brings in a certain amount of air to the soil, which has an oxidizing effect. The injurious effect of grass appears, regardless of the variety or age of the tree, or whether the tree is on dwarf or standard roots. In fact, the dwarf trees tried appear to be even more liable to injury than the standards, probably because these trees had shallow rooting habits. The pasturing of hogs, sheep and cattle in the sod orchard does not appear to overcome the bad effects of the grass.

It is on orchards in sod in the East and North Central states that we have some of the most startling increases in production when nitrate of soda is applied. The indications are that the trees are starved, especially for nitrogen, and when nitrogen has been applied to such, it has frequently been found in the East that the water supply was inadequate to bring the apples to full size. Too many apples were set. The average size of the apples secured under such circumstances is usually somewhat below normal. Thinning becomes necessary in such cases. So that even if the problem be considered in regard to food, and water be neglected, we do not attain the desired results. The beneficial effect of nitrate of soda or other nitrogenous fertilizer is equally marked in the far Western and other states where the nitrogen supply in the soil has been reduced by constant tillage. Nitrogen starvation may be due to more than one cause. Every system carries within itself the seed for its own destruction, and this applies to indiscriminate tillage and indiscriminate sod growth. If tillage is given for part of the year the amount of available nitrates in the soil rapidly increases. In New York one of the chief causes of unprofitable orchards is the growing of grass among the trees. In Iowa, Northwestern Greening apple trees in a blue grass sod averaged 5½ bushels of apples per tree, while those receiving tillage and cover crops and those in a clover sod averaged 8½ bushels.

Some Indiana results. At the Indiana Station a four-year experiment with young apple trees brought out the following:

1. Clean cultivation and a rye cover crop gave an average gain in girth of 5.17 centimeters.

2. A straw mulch, of 80 pounds per tree, with the grass cut and let lie, gave an average gain in girth of 5.19 centimeters.

3. Cutting the grass and allowing it to lie, mowing three times, gave an average gain in girth of 3.43 centimeters.

4. Cutting the grass and piling it near the tree, mowing three times, gave an average gain in girth of 3.63 centimeters.

Effect on soil temperature. The heavy mulch kept the soil a few degrees warmer in winter and cooler in summer, the minimum temperature being 34° F. maximum 69° F. Cultivated plats gave the widest and most rapid changes. At 9 inches deep, the temperature never registered below 31° F. nor went above 80° F. At this station it would seem that 10° F. is the maximum to which soil temperatures can be affected by methods of tillage. Between tillage and heavy mulch there is evidently little to choose under these conditions, but between either and grass there is much to choose. The apple tree evidently can thrive in spite of wide fluctuations in both soil temperature and atmospheric temperature.

Effect on roots. In Ohio, an attempt was made to keep a plat under continuous cultivation, but this was soon abandoned because of the injury done to the soil by erosion. The top soil would soon have been lost, exposing the roots of the trees and forming gullies. In the other parts of the orchard, it was found that the depth at which roots of the trees were located was practically the same whether under sod-mulch, sod, or when given cultivation and cover crop. The greater portion were found within the upper 6 inches of soil. Under these conditions, it was held that plowing the soil annually, as required for cultivated orchards, was a mere matter of pruning away valuable roots. This, however, does not appear to be worthy of very much weight, because most of the small roots live but one year and then die; so that their removal or the turning of the soil early in the season with shallow cultivation later would not be a detrimental practice. However, under the conditions where the soil is shallow and the subsoil so hard that the roots would not penetrate it, the sod mulch system gave a heavier and more vigorous growth than any other.

Conditions under which mulch may be advisable. There are certain conditions under which a sod mulch may be used advantageously. These are:

1. Orchards on steep hillsides where the land would wash badly under tillage.
2. On land covered with rocks where tillage would be impossible.
3. On soils having suitable depth and an abundant supply of moisture.
4. On soils which are retentive of moisture.
5. Economic conditions may determine between tillage and mulching. The growing of a relatively large area in sod may counterbalance the greater productiveness under tillage and

leave the same net income on certain soil types and under certain climatic conditions.

Cover crops. The policy of cultivating the land until July or some such date and then sowing a cover crop tends to enrich the soil in organic matter and improve its mechanical condition. The cover crop may prevent erosion and the blowing away of light surface soils, but any claims that it keeps the soil moist by shading it, or that it affords winter protection to the roots appear to be not well founded. Cover crops may aid in bringing about proper maturation of the wood, both root and branch, and thus better fit the tree to survive the rigors of winter. The growing of a cover crop is now recognized as a general practice in the management of orchards throughout much of the apple-growing territory, for almost all fruits under normal conditions it is doubtful economy to spend more than a dollar an acre for cover crop seed. A large number of cover crops are used. It is advisable that the crops be changed from time to time, since it is not always profitable to use red clover or cow peas or alfalfa, even though each is a legume and enriches the soil in nitrogen. One of the chief functions of the cover crop is to make the soil an agreeable home for the domesticated bacteria. These bacteria break down the vegetable matter and mineral ingredients of the soil so as to be available as food for the fruit crops.

As to cost. It frequently follows, that even if red clover is desirable, the price of seed may be so high that it may be profitable to substitute alsike clover for a year, remembering that 1 pound of alsike clover seed will furnish as many plants as 2½ pounds of red clover. Another year, if hairy vetch should not be too expensive it might pay to use it, sowing 20 to 30 pounds per acre in connection with a peck of rye, the rye serving to hold it off the ground. The vetch might be sown alone and allowed to stand one year, especially in a young orchard. The succeeding crop might be cut for seed, thus turning a cover crop into a catch crop. This would produce some revenue and enough seed would probably shell out so that if the orchard were disked over it would reseed itself for another year.

Again, in case both clover and vetch are high in price, 5 or 6 pounds of Dwarf Essex rape may be seeded. There are few crops which control quack grass as well as a good crop of Dwarf Essex rape. Buckwheat has the same effect on quack grass.

Dwarf Essex rape will grow 2 feet tall. In the North it is destroyed by frost in the fall, but its stalks remain to hold the snow. The following spring the land may be disked instead of plowed. Buckwheat is often a very satisfactory crop, sown 3 to 4 pecks an acre. If the orchard is young and there is a good crop on the ground, buckwheat may be cut and thrashed and the straw and some manure returned to the land. Usually there is not a very large return financially from buckwheat, but some years it may pay the working expenses of the newly planted orchard. Another year, a combination of a peck of buckwheat, one-half pound cow-horn turnip, 2 or 3 pounds of red clover, the same of crimson clover and 1 pound of alsike clover may be sown. At other times when crimson clover is cheap it may be used alone. It is one of the valuable crops in the Atlantic Coast states, from New Jersey to Virginia. It is rightly regarded there as one of the most satisfactory of cover crops. In the same locality, cow peas are frequently desirable, especially in young orchards. They might be sown early in June, either in rows 3 feet apart and cultivated, or 3 pecks used per acre sown broadcast. There is the danger with this crop that if the season turns dry it may become so well established that it will take the moisture from the trees. The injury is frequently more apparent with peaches than with apples, although sometimes the same trouble has occurred in New York

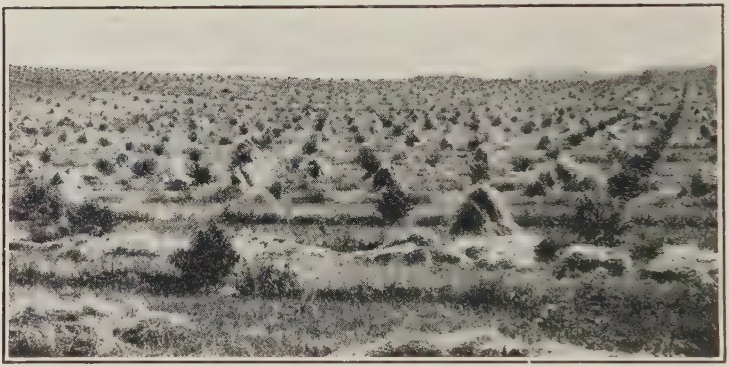


FIG. 33. Buckwheat in a young Pennsylvania orchard. Tillage is maintained until June when the buckwheat is seeded. The orchard is well located on a plateau. The slight roll to the land insures good air-drainage and yet is not sufficient to affect the cost of tillage.
Courtesy Dr. R. B. Reitz, Brookville, Pa.

when hairy vetch is grown among pears. A good stand of vetch and a dry fall may so reduce the vigor of the leaf buds as to impair the vigor the following spring, again demonstrating that we may have too much of a good thing.

In Atlantic coastal regions. In the region of the coastal plain from New Jersey southward, it is a straight case of tillage and cover crops. Among the important soil types are the Norfolk sand and sandy loam, upon which even a cover crop must be handled with discretion. If the season turns dry in August, it may be wise to destroy the cover crop to save the water for the maturing fruit crop. This is much more likely with peaches than with apples, but it may be true of the latter crop.

Soy beans. In Ohio and other sections, soy beans may replace cow peas, sowing 3 to 4 pecks to the acre. Frequently this crop is turned under although sometimes the crop is harvested for seed. Of course, it is always the tendency when cropping an orchard to secure some financial return. Whenever it is possible, this should be taken to reduce running expenses.

Barley and oats. In other districts, barley or oats sown at the rate of 2½ to 3 bushels an acre, sometimes from July to September, make a very good cover crop since in northern latitudes either is apt to winter kill and hence not give much trouble in the spring.

Rye. In other regions, rye is looked upon with favor, but its disadvantages are as serious and as numerous as its benefits. It may be sown late in the season and make a small growth but it grows rapidly the following spring, and unless turned under quickly may pump a lot of water out of the soil to the detriment of the fruit crop. If it becomes woody before plowing under, considerable moisture is needed to cause decay; hence it must be handled very carefully. The ill-effects of rye are not so apparent on apples as on peaches under certain conditions. There is a marked antipathy between the peach and rye, the peach being the sufferer. I know of nothing which will stunt a peach orchard so effectively as a crop of rye. Clover and peaches get along famously. The problem of plant relationship is a large one. Incidentally, I might mention that the black walnut tree in New York will frequently stunt and may kill, the apple, peach, pear and currant bush when their feeding roots come in contact with the roots of the black walnut. These plants will live immediately under a big black walnut, where the drip of the leaves may fall on them, but at a distance away from the trunk, where the main feeding roots are at work, there will be no vigorous live tree other than the black walnut. The feeding roots extend out about two to three times the spread of the branches. This indicates where the fertilizer should be applied. Rye seems to have a remarkable effect on quack grass and the growing of a crop of rye in fall, on an infested field, and plowing it under early in spring, and following it with a cultivated crop in the season or sowed corn or buckwheat will, if repeated, clean up quack grass as quickly as any other method.

Millet. Millet is frequently grown as a cover crop, with satisfaction. It makes a mass of material to turn under. The work done by Pennsylvania State College in regard to cover crops will bear careful perusal, and many suggestions may be derived from it by the eastern fruitgrower. The following table gives the rate of seeding, cost of cover crop seed in 1914, and the usual date of seeding for New York and Pennsylvania.

RATE OF SEEDING AND COST* OF COVER-CROP SEED

Crop	Pounds per acre	Cost of seed per pound, cents	Cost of-seed per acre	Date of seeding	Method
Crimson Clover	10 to 20	6½	$1.30	July 15-20	Broadcast and harrowed
Medium Red Clover	9 to 12	15	1.80	July 15-20	Broadcast and harrowed
Mammoth Clover	10 to 15	15	2.25	July 15-20	Broadcast and harrowed
White Clover	4 to 5	30	1.50	July 15-20	Broadcast and harrowed
Alsike	4 to 6	17½	1.05	July 15-20	Broadcast and harrowed
Sweet Clover	25 to 30	25	5.25 to 7.50	Jan. to May	Broadcast and harrowed
Hairy Vetch	30 to 40	7 to 12½	2.80 to 5.00	July 15-Aug. 15	Drilled or broadcast
Canada Peas	60 to 90			July 15-Aug. 15	Drilled or broadcast
Cowpeas (Black)	50 to 60	5	2.50 to 3.00	June 25-30	Drilled
Soybeans (Hollybrook)	40 to 50	4½	1.80	June 25-30	Drilled
Rye	90	1.3	1.17	Sept. 1-Oct. 15	Drilled or broadcast
Oats	75	1.5	1.13	July 15-Aug. 15	Drilled or broadcast
Millet	20	4	.80	July 15-Aug. 15	Drilled or broadcast
Buckwheat	48	3	1.50	July 4-10	Drilled or broadcast
Dwarf Essex Rape	4 to 8	6	.48	July 4-10	Broadcast and harrowed
Cowhorn Turnips	4	25	1.00	July 4-10	Broadcast and harrowed

* Prices prevailing in 1914 are taken, since these represent prewar conditions.

Plowing under cover crops. It is generally advised that the cover crop be left on the land all winter. We need to remember, however, that the whole system of tillage of orchards and the growing of cover crops in the Eastern United States in a systematic manner is probably about thirty years old and there is much to learn. Before that time practically all orchards were in sod all the time. There is a growing disposition on the part of orchardists, especially if they have heavy soil, to plow the orchards in December if the weather conditions permit so that cultivation may be done rapidly in spring. In Florida, it seems advisable to do this rather than to let the cover crop grow on the ground all winter. Some successful orchardists cultivate the orchard during the bearing year and allow the cover crop to carry over the following season. For instance, the cover crop may be sown the year the orchard is bearing its heavy yield, and be allowed to grow the following year, being plowed under late that fall. Red clover, hairy vetch, alfalfa and sweet clover may all be used under such conditions. The aim of the orchardist is to be as nearly self-sufficient as possible in regard to fertilizers. If it is possible to grow fertilizer, the orchardist is that much ahead and since nitrogen seems to be the dominant fertilizer in most orchards, the growing of leguminous crops will help in solving the problem.

Weeds. Many orchardists recognize the value of weeds. Pigweed (sometimes known as lamb's quarter) and red root, are probably two of the best cover crops to be found. They are nearly as rich as alfalfa in nitrogen although they get all of this from the ground so far as we know. They grow rapidly, especially in a wet fall. They do just what a cover crop should do—take up excessive moisture; and they seed themselves. Little more could be asked of a plant.

These two plants are perhaps the best cover crops for red currants in New York. One decided advantage under New York conditions is that they hold the snow well and by spring are so brittle that they can be crushed by a disk harrow, and the ground can be worked up without plowing. Their strong roots in the ground act as plows, the cavities left when their roots decay aerate the soil, and the incorporation of their stalks with the soil, keeps the organic matter where it is needed. Success depends upon using cheap help and there is nothing as cheap as the forces nature has provided.

Cover crops and water supply. Various experiments show that where cover crops are grown the organic matter of the soil is frequently much higher at the end of twelve years than it was at the beginning, or than it would have been if the land had been left in grass. At the New Hampshire station the soil moisture content was higher where a green crop was plowed under than where clean cultivation was practiced. In other words, clean cultivation of orchards without growing a cover crop, is not advisable. It was shown that even land in sod will hold more moisture than land which is kept under clean tillage continuously. It has already been pointed out that the moisture content affects the fruit yield, that when it falls between 6.5 and 7 per cent in a sandy soil and 12 per cent in a loam soil, the apple crop may suffer. The apple tree can take only so much moisture from the soil. The rest is held so firmly by the soil particles that the roots of the tree have not sufficient power to pull it away. It is of the utmost importance to maintain an adequate supply of moisture in the soil, and probably second to this is the nitrogen supply.

Cover crop and the nitrogen supply. Nitrogen in the form of nitrate is one of the most expensive fertilizers. Wherever a cover crop of the clover family is grown and turned under, the formation of nitrates in the soil is encouraged. These plants add nitrogen while they live, and of course, an additional amount is added when they are plowed under so that where this practice is regularly carried on no nitrogenous fertilizer may be necessary. In a sod orchard, however, the formation of nitrates takes place slowly, especially when the plants are largely grasses. It is on such that the addition of nitrates has had probably the most marked results.

Cover crops maintain productivity. Experiments show that trees receiving cultivation and cover crops store more starch in their cells, have more vigor, and set more fruit buds than do those standing in sod. In many cases, the addition of fertilizers to plats receiving tillage and cover crops fail to show any increase in yield, indicating that tillage and the cover crops supplied the needs, unless we take the other possibility that the fertilizers had been wrongly selected.

Some Hood River data. A survey of fifty-one Hood River apple orchards for the years 1913 to 1918 developed the following facts: From 1913 to 1915 the orchards received clean tillage and no cover crop, as was generally practiced. During the years 1916 to 1918 cover crops were grown and the use of nitrogenous fertilizer came in. Constant tillage had depleted the humus content. The cover crops and fertilizers were material factors in increasing the average yield per tree from 3.03 boxes to 4.45 boxes or over 46 per cent. A similar increase is seen in Wenatchee.

Terraced orchards. In Maryland, where orchards are grown on steep hillsides and planted on the contour it is not uncommon to plow every other year. The space between two rows of trees is cultivated one year, leaving the next row in clover sod, vetch or other crop, reversing the treatment the next year. This to done to prevent washing. Half of the roots of the trees are under cultivation each year. This method works out quite satisfactorily. These orchards are an interesting sight. The driveways run up the side of the hill, frequently at a 10 per cent grade. They are used for hauling water, spray material and the fruit. In some of these orchards the water is so located that it may be piped from above. The sprayers are filled from standpipes, or water pipes placed at intervals throughout the orchard. The advent of the duster has been of great value in reducing the labor attending crop protection in orchards so located.

CHAPTER XV

SOME PROBLEMS OF GROWERS

Frost injury. The loss of the trees by frost occurs from Canada to Florida. No part of the temperate zone is safe. Trees are lost in the nursery, in the young orchard, in the mature and old orchard. Often the injury to mature trees may not appear with the opening of the spring; the tree may send out its leaves and perhaps bloom and die in midsummer or later.

Trees most easily injured. The trees most easily injured are those which have been weakened:

(a) Thus trees which have borne a crop the year previous.

(b) Those which have lost their foliage prematurely as by an attack of caterpillars, by spray injury; or those which have lost foliage by being topworked; or young trees which have been heavily pruned to raise the head. In fact, trees which have an insufficient amount of foliage properly to perform the functions of the leaves are more tender because they have not developed a full supply of colloid bodies referred to below. There is something a tree gets, some reserve power secured when it carries its foliage for a normal period of time. If this operation is not completed before the leaves are removed, the tree is injured. The leaves seem to bring about the ripening of the wood.

(c) Those which have been injured by injudicious fertilizer treatment. This has been seen in Florida among citrus fruits.

(d) Those standing on land which is too wet.

Location of the injury. The frost injury may be in the buds, leaves, fruit, sapwood, bark, cambium layer, crotches, roots; or the trunk may be affected but not the branches, but the tree will die if the trunk is gone.

Hardiness in plants. Water freezes at 32° F., but some water held in the soil and in plants does not freeze at this temperature. In addition to free water, plants hold water by adsorption through the agency of certain colloid substances of which certain pentosans seem to be the most common in the case of fruits. The pectins which are recognized now by the jelly maker, cook and housewife as important fruit bodies in the making of jelly belong in this group of colloids. It is recognized that their formation in the plant can be at least encouraged by proper cultural methods. Water held by these colloids does not freeze at the normal freezing point, but varies from a few degrees below to —78° C. If it were not for these different ways of holding water, neither a fruit tree nor any other tree would live through a northern winter. In the case of fruits, we find that death of plants from low temperatures may be due to loss of water from the cells and by ice formation in the intercellular spaces. Hardy plants usually contain less water than tender ones. Experiments with certain plants show that dryness causes an increase in the development of certain colloid bodies as pentosans in the plant and the increase in these increases the amount of water which the plant can hold adsorbed by them. When the tree matures properly, these are developed to a maximum. One of the reasons for sowing a cover crop and ceasing cultivation early is to force maturation of the wood and the development of these substances. If the water is held in the plant in an adsorbed state it follows that it cannot be frozen at 32° F. and that the temperature at which it will freeze will vary with the colloid bodies formed.

COMMON FORMS OF WINTER INJURY

Root killing. The roots are much more tender than the tops of trees. Roots of apple trees if exposed, are killed by 10 to 12° of frost, that is, at temperatures of 18 to 20° F. In the Northern states and Canada root killing is most prevalent in dry winters of extreme cold. Sandy soils freeze deeper than loams. In the northern orchards a mulch of snow or a heavy cover crop tends to prevent freezing of the land. In regions where this injury is apt to occur it may be wiser to defer plowing under the cover crop until spring. Soils kept under clean cultivation without cover crops may have a lower moisture content than similar soils under sod or growing a crop.

Forms of treatment suggested are as follows: (1) In the orchard grow a good cover crop. (2) In the northern regions plant trees which are on hardy roots. In the case of apples, planting hardy varieties is of no avail, if these have been propagated on French crab seedling roots as usually grown, some of which may be hardy, others not. The remedy is to use native hardy crabs or seedlings of such crabs as Martha and other hardy crabs for roots, or to root hardy varieties. Until fruitgrowers realize that such trees are probably worth more than trees grown in the ordinary way, in a favorable region, few nurserymen will feel they can afford to try to solve this problem.

Bark splitting is often seen on sweet cherries and on young apple trees which are in a vigorous condition of growth. It is most common when the trees grow late into fall and a sudden cold wave occurs; or when the ground is covered with a heavy fall of snow and the ground is not chilled before the coming of the heavy freeze.

The rate at which the temperature falls is probably the most important factor in the whole question of winter injury. Chandler states that if the temperature fall is rapid enough, it is possible to kill almost any tissue of the tree at a temperature a little above zero. Peach buds have survived a temperature of 25 degrees below zero when this temperature has been reached at the end of a period of relatively low temperature and the buds had been kept frozen solid day and night for some time. Peach buds have been killed at a temperature of eight degrees below zero when the change in temperature was rapid and the low temperature caused rapid freezing of unfrozen tissue.

In bark splitting the bark of the tree is found to be loose. Most often this is seen at the crown and is then known as "crown rot," although crown rot may be due to other causes. The trouble is most common in strong-growing varieties like Gravenstein, the variety most commonly injured in Nova Scotia. This variety is, however, inherently weak in many ways; in my experience it is one variety in which crown gall is found most frequently. The remedy is to stop cultivation early in the season. Grow a cover crop. Head the trees low. Nothing can be done to check the sudden freezes except to find varieties resistant to them.

Trunk splitting occurs under conditions similar to bark splitting. The trunk splits, owing to the uneven expansion and contraction of the cells of the medullary rays during sudden changes of temperature. The same treatment applies as for bark splitting.

Sunscald is a very common form of winter injury through New England, part of eastern New York and eastern Canada where there are days with bright sunshine and rapid changes in temperature in the winter. Vermont and eastern New York have about one hundred and eighty bright days in the year and eighty cloudy. A number of the bright days are during the winter. Ithaca in western New York has about eighty bright days and one hundred and eighty cloudy. Sunscald occurs in eastern New York. It is not a serious trouble in western New York. Scab, a disease which spreads easily in dull moist days is a serious trouble in western New York, but not nearly so much so in Vermont. Young trees suffer most from sunscald. In the nursery the trunks are shaded by other small trees but in the orchard they stand alone. The bark on the south and southwest side of the tree dries up and falls off. The condition occurs in late winter and early spring. The sun's rays thaw the frozen tree unevenly and cause it to shed its bark. It is probably the rate of the fall in temperature when the sun goes down that causes the damage. The temperature on one side of the tree had been raised in the daytime and falls rapidly at night, causing unequal contraction and the bark separates from the wood beneath it.

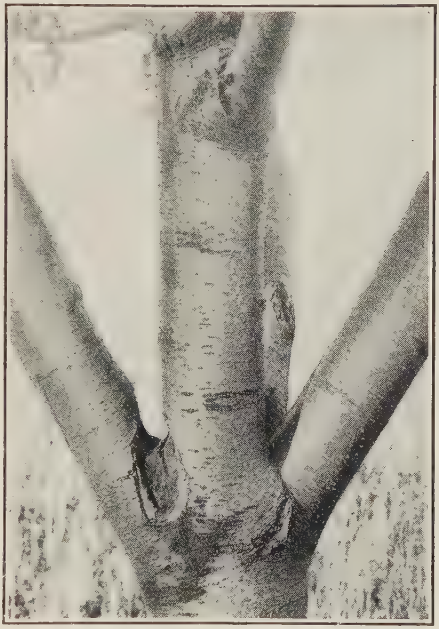


Fig. 34. Crotch injury. Very difficult to treat. Better avoid crotches when forming the head of the tree

Treatment is along the following lines: 1. In planting, tip the trees to the south, so that the shadow of the top may fall on the trunk. 2. Leave the lowest limb on the south side when planting. 3. Head the trees low. 4. Wrap the trunks with building paper, not tar paper, for the winter; remove in spring. 5. Use wooden veneer guards. Place a shingle in the ground on the south side of the tree so its shadow will fall on the trunk. Avoid anything which will attract mice.

Crotch injury. Death of the bark in the crotches of the tree is seen in the Northern states and eastern Canada. It occurs in the winter and is believed to be due to frost. In some cases it is traceable to other causes as cankers but these explain in part only. The remedy is to avoid crotches when forming the head of a tree. The trouble is most frequent in open center trees. Training with a central leader enables one to avoid this difficulty. See that the angle a limb makes with the trunk is not too small. If two branches of equal vigor start from one point to form a double head, which is often seen in Rome Beauty and some other varieties, remove one as soon as seen. If the crotch injury threatens to girdle or nearly girdle a limb it may necessitate its removal. A bearing tree showing crotch injury should be braced.

Crotch injury is one of the most difficult of all forms of winter injury to heal. One cannot tell where the cambrium layer is killed, hence it is advisable to delay any attempt to clean the injured crotch out until it has had at least a year to try to get well of itself. The bark is usually more resistant to frost than the sapwood, but if conditions have been unfavorable for its maturation it may be killed as easily as the sapwood. The proper maturation or ripening of the wood is the best means of avoiding the various injuries to it. Probably the reason the crotches suffer is that the foliage on the inside of the tree is insufficient to properly mature the bark it supplies. The correct opening-up of the tree so that all of the foliage may receive an adequate supply of sunlight would aid materially in reducing this trouble. It is in evidence on varieties which are apt to grow thick, in which the sun fails to reach the center of the tree. The tissues of both the bark and wood of a crotch have a higher nitrogen content than normal and differ from normal in structure also.

Killing of the bark occurs on trees which are not adapted to endure the conditions. It is often seen in peaches in northern localities and in some varieties of apples. There is an inherent weakness. It is often seen after a tree has borne a heavy crop and its vitality is lowered. Even Ben Davis when growing in Canada often shows this tendency. The remedy is to thin the crop of fruit and maintain the vigor of the tree. The tree may have been growing too late and the wood be immature, in which event the tips contain more moisture than the branches lower down and they freeze first. Force earlier maturation of the wood. Select hardy varieties.

Black Heart. The winter of 1917-18 caused some fruit trees growing in the nurseries of New York to be injured. When the trunk was cut into, a black center was shown which is known as black heart. It is common in Canada. Its prevalence necessitates a somewhat different management of the nursery stock than is practiced in New York and further south. In New York, nursery stock showing black heart has in the past been regarded as unsalable.

Handling nursery stock in Canada. In case the first year's growth of budded trees and root grafts show black heart the procedure is as follows: After danger is past the nurserymen top these back to a point where the wood is not injured, the second year's growth may not be injured. If it is, the tree is cut back again. Usually it does not necessitate the removal of so much wood, and the tree is allowed to start up a third time, when it may succeed.

In the orchard. Young trees just planted and older trees may show it, the tender varieties more so than the hardier. Trees badly affected may make a more spindly growth but if given good treatment they grow on as though unaffected. Large bearing trees when old may become hollow, due to the entrance of rots; finally they blow over. In the black-hearted trees the cambium layer, where the live tissue is located, continues to function unimpaired.

Discolored sap wood. Some of the more tender varieties of pears, such as Bosc, generally show a discolored or slightly browned sap wood. It also occurs in other fruit trees. Sudden and violent changes in temperature during winter will cause it, but so far the author has seen no damage resulting from the planting of such stock. The trees grow as well as others. With more cold weather such trees might turn black hearted.

Of the woody tissue, the sapwood is the most tender, the older, inner layers being more tender than the outer, younger layers. The water moves from the roots in the sapwood to the leaves; hence when it is injured the rate of travel is impaired and we may expect a feeble growth. In bad cases there may be barely sufficient moisture moved to start the terminal bud into activity, but if growth takes place and a new layer of sapwood is developed, the water will move rapidly up this and we may get a good secondary growth of healthy twigs. The following year the trees may be fully recovered.

Trunk or body injury. When high winds accompany low temperatures it not infrequently happens that the water is literally frozen out of the trunks of the trees. It happened to peaches by the thousands in New York in the winter of 1917-18, and to many apple trees. It occurred in the winter of 1906-07 in Quebec and Ontario and frequently happens in the Canadian Northwest. Macoun suggests that the reason the bodies die and the branches live is that the branches contain more moisture than the trunk. Trees in sod orchards will die when those in cultivated orchards, which contain more moisture will not. It may be that the reason the trees in sod die is that they lack adequate vigor to fully ripen the wood. Ice freezing around a tree will kill it under certain conditions. Veneer protectors and soil mounds are both dangerous under such circumstances. The remedies suggested are: 1. Give good tillage and ripen the wood. 2. In very exposed places protect the trunks (possible for a few trees only) by sacking. 3. Plant wind breaks. 4. Use hardy trees.

Death of cambium layer. Under normal conditions, the cambium layer and the wood buds are the hardiest tissues in the tree. On light soils there is more danger of checking the growth too soon than in letting it continue too late. The worst possible condition is when a dry spell forces the wood to mature in June or July and then a subsequent wet fall forces the cambium layer into a late growth, and this is caught by a rapid fall in temperature. The loss of the cambium layer is one of the most serious of all losses, for it involves the death of the tree. Giving general good care is all that can be advised to safeguard against such loss.

Death of buds by drying. Fruit buds are often destroyed by frost, and sometimes the wood buds also, but they are more hardy. Death appears to be due to drying out. The water in the developing buds may be moving freely and not held by adsorption, hence be more easily frozen. Peaches may survive a fall in temperature to 20 degrees below zero in one locality, but be lost in another. If the moisture content of the atmosphere is increased as by proximity to water, the buds will endure more cold. A dry cold kills the roots of the trees; it does the same to the buds. Peaches, plums and cherries usually suffer most in the north. Whether wood or tissue has been frozen or dried to death can be seen by cutting the twigs and inspecting the cambium layer or the buds. Frozen tissue is brown; dry tissue is white. The remedies suggested are: 1. In a garden the trees may be given winter protection or laid down. 2. Trees in a garden may be trained near the ground. 3. The commercial hope lies in breeding hardy varieties.

Premature swelling of the buds often happens with peaches, plums and cherries. The buds start prematurely and are killed by late frosts. The maturity of the buds in early winter varies with the season. If the summer is hot and dry it is favorable to the early maturation of the fruit buds. If the summer is below normal in temperature and short, the fruit buds will be less mature and will not start so early in spring. Burbank plums tend to mature their buds early so that with this fruit there is less likelihood of loss from late freezing of buds if late growth be encouraged.

Frost injury to flowers. Usually fruit buds will tolerate lower temperature before they open than they will when in full bloom. A temperature of 25 to 27° F. may cause injury to apple blossoms when fully open and after the blossom falls they are still more easily hurt. A temperature of 27° F. may be fatal. If a frost causes the center of a bud or the pistil to turn brownish before the flower opens the fruit will not set. The bud is dead. If it occurs after pollination the brownish appearance of the pistil may be normal, pollination may have already taken place and the pistil done its work, or it may have been killed by the frost.

Frost injury to fruit. Frequently a crop of apples is lost in some of the Central states after the apples are the size of marbles. At this time the fruit is easily injured. The remedy is the development of late blooming varieties and such are now being introduced.

Russeting of fruit. Sometimes the frosts which occur after the fruit is formed are not sufficiently severe to remove the crop, but they leave their impress on the part of the apple which was exposed and it appears as a russeted area often on the calyx end, sometimes on the stem end or as a band around the apple.

Freezing in autumn and in transit. Crops are often frozen on the tree in the fall before they can be harvested. In the apple a light frost may do no harm, provided one does not touch the fruit until the sun is up and the sap has had time to circulate and thaw it out. If picked while frozen or even while severely chilled it will not keep. Never touch an apple while there is frost in it. A frosted or frozen apple is easily recognized by its wrinkled skin and the texture of its flesh, but if buying apples in a frost district, it is wise to cut some to see whether they have been hurt by frost.

The remedies are:

1. Study your district. Find the date of the earliest killing frost and plan to have varieties which will mature in time.
2. When the crop is ready, get it off. Pay the price to get the help.
3. If a crop has been frozen and apparently comes back so that it is saleable, it is usually wise to get it into consumption as quickly as possible. It is not wise to attempt to hold such fruit.
4. Apples freeze and suffer injury from freezing at varying temperatures, depending upon the variety, season and other factors. Most apples begin to freeze around 28°F. but with many varieties the temperature must fall below 26°F. to start ice formation in the fruit. At this temperature considerable injury may occur. With most varieties at 23° F. the apple is so badly injured it is of little commercial value. If such frozen fruit can be further frozen at once and held at zero to 10 degrees above it may be held almost indefinitely and while not equal to unfrozen fruit it still has high food value when properly cooked, and is palatable. Strawberries, raspberries, blackberries, plums, peaches, cherries may be held a year in good condition for cooking at a temperature of from zero to 10 degrees above. Cherries, various berries and Concord grapes so held are almost as good for cooking as fresh fruit.
5. Grapes freeze at various temperatures according to the variety. The Emperor may not show freezing until the temperature reaches 22°F. and remains there for some time, but the usual freezing temperatures range from 24.5 to 26°F. The imported Spanish Almeria may begin to freeze at 27 to 28°F. At these temperatures ice formation begins in the fruit, causing much loss. Grapes are best held at 30°F. in storage.

Hardiness of varieties. The roots of most fruit trees in New York are killed at a temperature of from 18 to 20° F. The roots of gooseberries, currants and such varieties of grapes as Bacchus and Clinton will withstand lower temperatures.

In New York many varieties of pears are little more hardy than peaches. The most tender variety is Duchesse d'Angoulême followed closely by Bartlett, Beurré Bosc and Beurré Clairgeau. In Oswego County, N. Y., Bosc trees were killed under conditions which Bartlett trees survived, but failed to carry their fruit buds, while Seckel bore a crop. Kieffer is variable, frequently as tender as Beurré Bosc, but when grown where it has a long season and can mature its wood it is hardy. Clapp Favorite is more resistant. Seckel and Sheldon will carry a crop where the Bosc trees will be killed, and Beurré d'Anjou and Flemish Beauty seem to be the hardiest. The pear, like the peach, shows considerable power of recovery. Trees in which the sapwood, spurs and branches seemed to be almost killed, recover and bear crops. At Ithaca, N. Y., the European varieties of plums such as Reine Claude and Italian Prune are more hardy than peaches and sweet cherries and bear crops under conditions when the wood of Baldwin, Rhode Island Greening and Tompkins King apple trees was seriously injured, but in more exposed regions of the states the plum trees failed to carry their crop, but apple trees were also injured. Japanese plums proved more hardy than peaches and sweet cherries. Peaches recover much more rapidly than one might think possible, but sweet cherries fail to recover as well as one would expect them to.

How to handle a frozen tree. The best way to handle a badly frozen tree is to leave it alone, but give it good care, tillage and fertilizer. The dead wood may be removed after growth has started, but no live wood should be removed for a year. This enables the tree to make new sapwood that next year may be put to work. Heavy pruning of frozen trees is a mistake. Leave them alone.

In New York, in the severe winter of 1917-18, McIntosh and Oldenburg apple trees proved to be the hardiest commercial apples. Nearly all Russian varieties were quite hardy. Fameuse and Wealthy were injured. Almost all the Fameuse trees in the province of Quebec were seriously hurt and some were destroyed that winter. In parts of New York, practically every important commercial variety was injured. Baldwin apple trees continued to give indifferent crops for several years afterward in parts of New York and other states. The winter of 1917-18 merely confirmed that of 1903-04, for in the latter year, extremely cold weather lasted for twelve consecutive days in Ottawa, Canada, on six of which the temperature went to 20 to 30 degrees below zero. In this test, McIntosh proved to be more hardy than Fameuse and 164 varieties of apples which had endured previous winters succumbed in 1903-04. Trees that will endure very low temperatures for a day will not live through a week of such. Each variety has a place in the list with perhaps Hibernal as one of the most hardy and perhaps Yellow Newtown as the least hardy. Young Northern Spy trees were hurt much more than the older trees, the common injury being in the crotches. This variety starts its branches at an acute angle and the young trees are apt to be vigorous growers and have heavy foliage. The foliage of the inner branches is so shaded that proper maturing of the wood is not performed, hence the injury.

Other resistant varieties were Twenty Ounce, Wagener, Delicious and Rome Beauty. Northern Spy was less resistant than Ben Davis, the latter showing little injury except in the coldest regions. The most tender variety was the Baldwin. Thousands of bearing size Baldwin trees were killed in Maine and vicinity in the winter of 1917-18 and there was a high mortality in New York. Many Maine and New England growers contend that Baldwin is injured and may die at a temperature of 19 degrees below zero with a high wind. During that winter the temperature fell to 27 degrees below zero with a northwest wind. Rhode Island Greening and Tompkins King were nearly as tender as Baldwin. Hubbardston, Fall Pippin and Gravenstein must be rated as tender varieties. The fruit buds of Hubbardston are killed at temperatures which will not destroy Baldwin, Twenty Ounce, McIntosh, Wealthy and Oldenburg.

CHAPTER XVI

INSECTS WHICH ATTACK THE APPLE

More than five hundred insects attack the apple. A great many of those here mentioned as apple pests attack other fruits also.

Insects Attacking Fruit

Codling moth (*Carpocapsa pomonella*). This insect is one of the leading injurious insects of the apple. It also attacks many other fruits and some nuts. Probably it does least injury to the apple in Nova Scotia and the maritime provinces of Canada where conditions are not particularly favorable to its existence. It increases in importance as we go southward and westward. On the Pacific Coast it is a most serious trouble. In northeastern sections there is usually but one brood. In the central-western there may be two, and in the southern regions and on the Pacific Coast there may be three. The program of control is modified to some extent by conditions.

Where one brood occurs egg-laying takes place about two weeks after the petals of the apples fall. These hatch in from six to ten days; three to four weeks after the petals fall the larvæ, after feeding slightly on the foliage, crawl to the fruit and enter, in the majority of cases at the blossom end. A few enter at the stem end. Or if two apples touch or a leaf covers the apple they start to burrow at the point of contact. Those entering the calyx end of the apple feed slightly in the calyx cup, then proceed to burrow to the core and devour the seeds. Finally they work their way out and escape. The second brood frequently eats out a small burrow or cavity at the side of the apple, beneath the skin, and works from this point. Many of the larvæ leave the apple before it falls to the ground. They spin a cocoon under the bark of the tree and there they may remain until the following spring at which time they pupate and emerge to complete the cycle. In some cases, as in Georgia, some of the insects complete the cycle the same year, giving two broods and in some places three in one year. Many parasites feed on the larvæ. The Downy Woodpecker, Nut Hatch and

Chickadee destroy great numbers of the larvæ, hunting for them under the bark during the winter months. These birds should be encouraged by placing suet in the orchard during the winter.

Codling moth control. Where there is but one brood, the insect is fairly easy to control. Where there are two (and this is common in New York and like territory), it is more difficult. When the hatching is delayed, as it frequently is, the problem is further complicated, for the insects do not all hatch on time and practically two broods have to be fought at one time. The philosophy of spraying is to fill or coat the calyx cups with an arsenic poison in some form; usually arsenate of lead is used, although today calcium arsenate, magnesium arsenate and other compounds are available, but their use may not always be advisable. It is important that the work be done on time. It usually must be begun when three-fourths of the petals have fallen and should be finished before the calyx cup is closed by the sepals folding over it. In the far west, spraying must be done with great thoroughness. The general practice is to use a fine

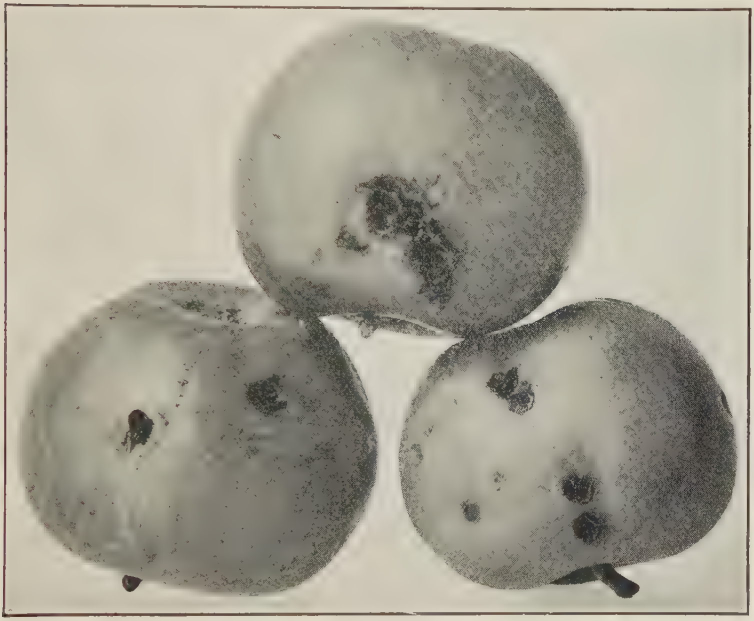


FIG. 35. Wormy apples. The work of the Codling Moth, showing side worm injury *Dr. Felt*

penetrating mist as a spray at sufficient pressure to place the poison deep in the calyx cavity. When the calyx cup is closed, the work cannot be very well done. Frequently there are only three to five days in which the work can be done properly. Dusting in many instances has proven remarkably effective.

When the weather is cool during the hatching season, even in a region like New York it will be advisable to give a second spraying seven to ten days later to coat the young apples and the new foliage in order that the late hatched insects may be satisfactorily controlled. In such seasons there is frequently considerable second brood injury. Personal contact of the owner with the work is necessary for success in controlling this insect.

Side injury. If the season is cold about the time the apples are in bloom, some of the codling moth eggs will fail to hatch. The result is they come along after the calyx is closed and seek to enter the young apple at the side, causing the side-injury. In New York the damage is done the end of June or early in July. If the temperature drops below 60° F. during the period of bloom one may expect side injury. The amount will depend upon the way in which the spraying was done the previous season. If the orchard is not in bearing, give a spraying at codling moth-period strength about three weeks after the period of bloom. It will reduce the number for the succeeding year.

The important things about this spraying to control codling moth are: 1. We must have a poison that will kill. 2. We must put it where it will kill. 3. We must put it on at the right time. It is often time well spent to take 50 per cent more time and do the work well. If dust is used coat the trees from both sides and make sure that the tops of the trees are coated.

The lesser apple worm (*Enarmonia prunivora*). The work of this insect is frequently mixed with that of the codling moth. The insect is smaller, but its eggs are laid and hatch about the same time, and it may be controlled in the same way as the codling moth. In the North there are two generations annually; in the Ozark regions there are three and sometimes a partial fourth brood. This insect also attacks plums. When present, a second spraying as for codling moth, or even a third may be necessary.

Apple fruit miner (*Argyresthia conjugella.*) This small insect is sometimes quite a serious pest in West Canada. The larvæ enter the fruit at the side of the apple, thus injuring it. Thorough spraying with an arsenical poison as arsenate of lead is suggested.

Apple maggot (*Rhagoletis pomonella*). This native insect is found in the Eastern United States and Canada. The injury is caused by the whitish maggot which burrows in all directions through the fruit. The parent is a fly. Where present, the tree should be sprayed early in July with arsenate of lead, giving a thorough spraying to coat the fruit and foliage. Since there are twenty to thirty days before egg laying in which the flies take up moisture which may be on the foliage, some advise adding molasses or syrup to the poisoned spray to make it more attractive. This does not appear to be necessary, although it is sometimes used to control other fruit flies.

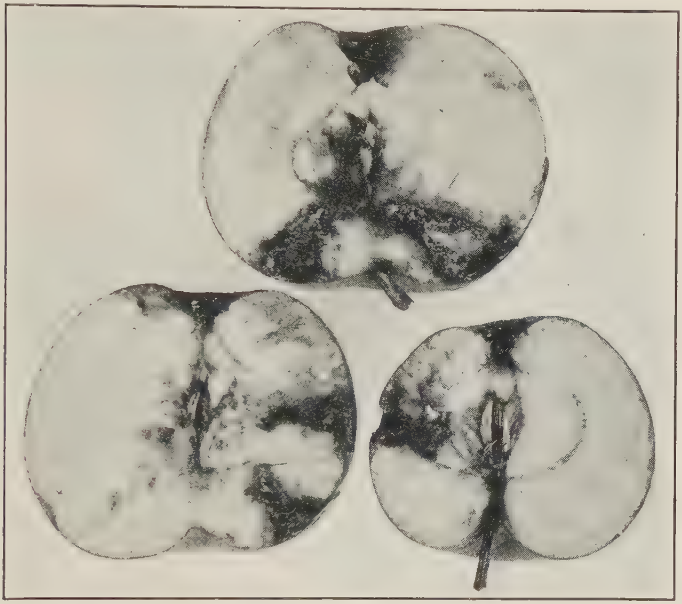


FIG. 36. Wormy apples. Sectional view of apples affected by side worms, i.e., these Codling Moth larvæ entered the side of the apple and not at the calyx. Late hatched larvæ may enter this way
Courtesy Professor Felt

Red bugs. The knotty apples which are caused by these insects are probably more familiar than the insects themselves. Their work must not be confused with that done by the plum curculio which deforms the fruit but leaves its characteristic feeding and egg-laying punctures. In addition, plant lice or aphids may cause stunted or misshapen fruit.

There are two red bugs: the apple red bug (*Heterocordylus malinus*), and the lighter-colored or false apple red bug (*Lygidea mendax*). These are sucking insects. The eggs are usually laid in the bark. The majority of the eggs hatch after the opening of the leaves of the fruit buds and before the blossoms open. The eggs of the false red bug and some of the red bug may hatch as late as the time when the trees are in bloom. It will thus be seen that the time at which these insects can be caught is just before the blossoms open and just after the trees have gone out of bloom. If present, an application of Blackleaf 40, of standard strength as used for aphis, will usually be advisable. In some seasons the time available for controlling this insect is but three days before bloom and three days after. The insects are very small and of a brilliant red color. The damage is done by the feeding punctures, which stunt the apple. The leaves also may be so badly punctured that they curl and in some cases, drop off. Dusting with finely ground tobacco, nicotine sulphate and lime have proven quite effective in New York, and with the author tobacco dust alone has been better than spraying. Excellent results were secured by dusting early in the morning, while the dew is on and the air still, so that the fumes hang in the orchard for some time. Others advise dusting in the heat of the day. It is important that there be no wind so that the fumes hang in the orchard.

Apple curculio (*Anthonomus quadrigibbus*). Three weevils are of marked importance. These are: Apple curculio, plum curculio, apple weevil. The two curculios are somewhat similar and they do similar work. They are found over a considerable apple-growing area. Curculios are snout beetles. They puncture the skin of the apple, tear off the skin and feed on the pulp. In addition, eggs are laid beneath the skin of the plum, thorn apple, pear, hawthorn and sometimes the apple. The eggs hatch and the larvæ live in the fruits for a while, frequently they remain twenty days and emerge as beetles. Few larvæ reach maturity in our cultivated apples; the flesh is too firm.

Thorough spraying for the codling moth will usually control the curculios. Curculios are a more serious menace if the trees are too thick. The chief damage is done by the adults who puncture the fruits. Clean orchard methods usually aid in control. The apple weevil usually feeds more or less on the foliage; hence, thorough spraying given for the codling moth, with arsenate of lead, keeps it under control.

Green fruit worms (*Xylina spp.*). At least three of the members of this family have caused considerable loss at times. They attack not only apples, but pears, peaches, plums, apricots, quinces and currants. They are large green worms, 1 to 1½ inches long. The worms usually work during May and June. They usually eat one side of the fruit and move from fruit to fruit. They are difficult to control when of large size, but spraying with arsenate of lead about the time the leaves are emerging and about the time that the young worms are hatching, will usually poison them so that the control exercised for case bearers will generally be sufficient to control these.

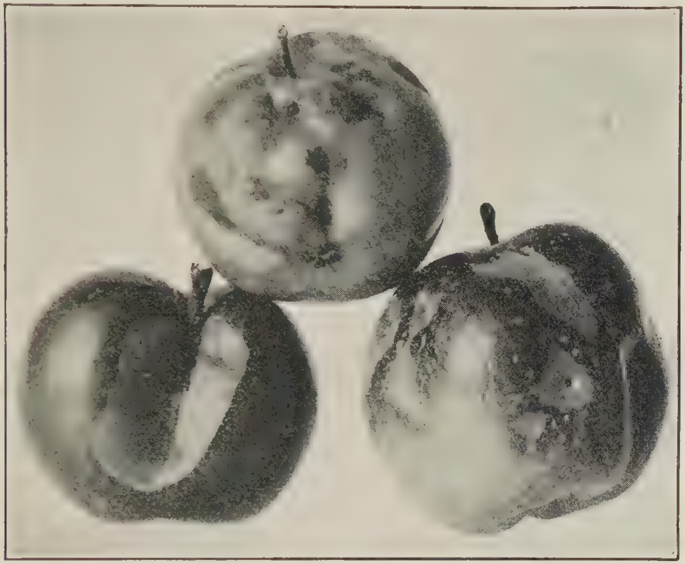


FIG. 37. Apples seriously injured by the Green Fruit Worm
Courtesy Professor Felt

INSECTS ATTACKING BUDS AND FOLIAGE

The bud moth (*Tmetocera ocellana*) is distributed throughout the whole of the northern apple belt. It attacks apples, pears, plums, cherries, quinces, peaches, blackberries and other fruits. The caterpillar is about one-half inch long, a cinnamon-brown color, with a black head and black legs. It emerges early in spring, as soon as the buds begin to open, and gets into the opening buds where it feeds on the expanding leaves and flowers, tying them together with silk threads. In these it lives six or seven weeks. Sometimes these insects feed on the young apples, causing a blemish. They continue to feed on the foliage during the summer. Usually there is one brood. Bud moths are somewhat difficult to control, but thorough spraying with arsenate of lead, 2 pounds to 50 gallons of water as the leaf buds are opening and when the blossoms are opening or just previous to this will usually control them. Spraying for scale may be delayed and a combined spray made for both San José scale and bud moths as above.

The cigar-case-bearer (*Coleophora fletcherella*) attacks apples, pears and plums. It is distributed over a considerable territory in the Eastern states and is reported in Montana, British Columbia and other points. In the middle of April, the caterpillar proceeds to eat holes in the opening buds, the expanding leaves and sometimes the flowers, doing considerable damage. Later, the orange-colored black-headed caterpillar, about one-fifth inch long, makes its cigar-shaped case or suit on the surface of the leaf. The spraying given for bud moth usually controls.

Pistol case-bearer (*Coleophora malivorella*). This insect is equally destructive and is recognized by the shape of its case. It is widely distributed and is controlled as advised for bud moth.

The Palmer-worm (*Ypsolophus ligulellus*) has done considerable damage at times in the eastern United States. The caterpillar is not over one-half inch long and moves with a wriggly motion when touched. The caterpillars skeletonize the foliage and eat deep cavities in the sides of young fruits. They sometimes fasten two or three leaves together with their silk. Spray with arsenate of lead, 2 pounds to 50 gallons of water; or dust with same.

The ribbed cocoon-maker of the apple (*Bucculatrix pomifoliella*) is distributed over the eastern half of Canada and from Maine to Texas. The larvæ skeletonize the foliage, causing the leaves to turn brown and curl up. In New York there may be two broods. The insects spend the winter in cocoons usually on the lower branches of the trees. The insect is often controlled by parasites and birds, but if it becomes a menace, spraying with dormant strength lime sulphur or miscible oil, 1 gallon to 10 of water in the dormant season in early spring, will probably destroy the cocoons. To control the caterpillars apply arsenate of lead in June.

The lesser apple leaf-roller (*Alceris minuta*) is the yellow-headed cranberry worm. It is therefore of dual importance in the cranberry regions of Massachusetts, in which there are two broods. In Missouri there are three . It is controlled by spraying with arsenical poisons just as the leaves are unfolding in spring, repeating in a few days. Certain parasites and birds destroy it. If the first brood be controlled it may give little trouble. If not, a later spraying as the eggs are hatching may control.

The fruit-tree leaf-roller (*Archips argyrospila*) is one of the most destructive of the leaf-rollers infesting fruit trees. It attacks many kinds of fruit and has done damage in New York, Missouri and Colorado. It is recognized by the rolling of the leaves. Sometimes the fruits are rolled in the nests; also holes are eaten in the sides of the fruits. The caterpillars reach three-fourths of an inch in length and are light green in color, with a head, legs and thorax shield varying from brown to black. They are a distinct menace. Various insects and red-winged black birds will destroy them. Eggs are laid, attached to the bark; and spraying these with miscible oil, or scalecide, 1 to 12, early in spring while the trees are dormant is suggested. Arsenate of lead, 2 to 3 pounds to 50 may be applied to the buds as they are breaking and a second spraying as the cluster buds begin to separate.

The Oblique-banded Leaf-roller (*Archips rosaceana*) and the Four-banded Leaf-roller (*Eulia quadrifasciana*) attack the apple and other trees and both are widely distributed in Northern United States. They are controlled as outlined for the Fruit-tree Leaf-roller.

Apple leaf-skeletonizer (*Canarsia hammondi*). These small greenish or brownish caterpillars skeletonize the leaves of the apple trees in the Mississippi Valley. They are usually controlled to some extent by parasites, but spraying with arsenical poisons as soon as they begin their work will destroy them.

The leaf-crumpler (*Mineola indigenella*) is found distributed over a considerable portion of the United States and Canada. The young brown caterpillars feed upon the tender leaves. Spraying with arsenical poisons just before and after bloom is advised.

Leaf-mining insects. Certain leaf-mining insects attack the foliage in various parts of the country. The plowing under of the fallen leaves may destroy the larvæ; or spraying the foliage with Blackleaf 40 to which soap has been added, standard strength may reduce them.

The spring canker-worm (*Paleacrita vernata*) is one of the oldest and most destructive American orchard pests. The caterpillars appear in early spring and defoliate the trees. They are common from Canada to Texas and occur in California. They are readily controlled. Cultivation of the orchards destroy many of the pupæ which have entered the soil to pupate. Spraying or dusting the trees just before the blossoms open and again after the petals fall with an arsenical poison will usually control them. In some cases, the trees may be banded.

Tree Tanglefoot may be used for the spring canker worms. It consists of a mixture of 5 pounds of resin and 3 pints of castor oil. Some add Venice turpentine, 3 pints, and printer's ink, mixed with black Virginia oil or similar heavy oil to prevent its drying out too quickly. Another recipe is: Boil together 9 pounds of resin, 7 pounds of castor oil and one-half pound of paraffin wax. If too soft, add more resin, if too hard, more oil. One pound will band seven or eight ordinary size apple trees. This applied to the band of tarred or other heavy paper 6 or 8 inches wide, is tacked around the trunk after it has been smoothed and any roughness filled with cotton. This band will need resmearing as it becomes coated with the dead bodies of the insects. It may be used to protect elms and other trees.

The fall canker-worm (*Alsophila pometaria*) is found throughout the northeastern United States and in western California. It attacks apples, plums, prunes, apricots, cherries, etc. The moths emerge and lay their eggs in fall, hence the name. In other respects, the life history is the same as the spring canker-worm, and the control similar.

White-marked tussock-moth (*Hemerocampa leucostigma*). There are three species of these tussock moths which injure orchards. They damage a considerable number of fruits in Canada and in the eastern half of the United States. Several kinds of birds destroy them, and they have many parasites. Gathering of the eggs by school children will reduce the number; spray with arsenical poisons once or twice while the caterpillars are small; banding the trees as mentioned for canker-worms will prevent their climbing up the trees.

Fall webworm (*Hyphantria cunea*). This insect feeds on at least one hundred different trees throughout the Eastern states and in California. In the South it is sometimes a serious enemy of the pecan. It is well known with its unsightly nest. It is usually held in check in the forest by natural enemies. In orchards where arsenical spraying is practiced, most of the first brood may be destroyed, and with the destruction of these, control is relatively easy. The webs may be burned out of the shade trees that have been neglected. Burning should be done in the day time, when practically all of the caterpillars are in the webs. Destruction by burning of the nests is apt to injure the tree seriously.

Apple-tree tent-caterpillar (*Malacosoma americana*). The conspicuous nests of these insects on wild cherry trees and in neglected orchards may be seen from the Eastern United States to the Rockies. The insects attack apple, peach, plum and other trees. Periodically they rise in importance, sometimes becoming quite a menace. The full-grown caterpillars are 2 inches long and soon do considerable damage. They are usually kept in check by parasites, birds, toads; also bacterial diseases aid in controlling them. When winter-pruning trees, the eggs which are conspicuous should be removed by hand. In orchards which are regularly sprayed, the young larvæ are generally destroyed by one of the sprayings. If they have been allowed to become abundant the nests should be cleaned out by hand. It is not wise to burn them in fruit trees, since the bark which is burned usually is injured or destroyed.

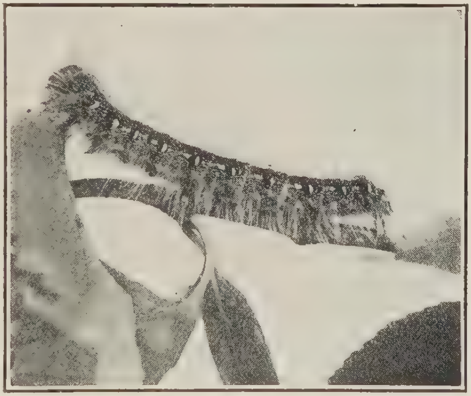


FIG. 38. The apple tree tent caterpillar, a leaf-eating insect which is destroyed by placing poison on its food, viz., the leaves

U. S. D. A.

The forest tent-caterpillar (*Malacosoma disstria*) usually confines its work to the forests, but occasionally enters fruit orchards, doing considerable damage. If orchards are located near woods, it may be necessary to band the trees to prevent the insects ascending the orchard trees. They are quite capable of migrating a considerable distance.

Red-humped apple-caterpillar (*Schizura concinna*). These insects feed in colonies and are recognized by the red hump. They are often seen on fruit trees in August and September. In the North there is usually but one brood, but in the South there may be two. They are usually destroyed by spraying with arsenical poisons.

Gipsy moth (*Porthetria dispar*). This relatively recent introduction is slowly extending the area it occupied in New England. In orchards it may be controlled by going over the trees in the winter and treating the egg masses with crude coal-tar creosote to which a little lamp black has been added, as a marker. If the eggs are saturated with this, they are destroyed. If the caterpillars hatch, it is advisable to spray early with arsenate of lead 5 pounds to 50 gallons. If they once become full-grown they are difficult to poison. Banding of the trees will prevent their going up orchard trees when they are migrating.

Brown-tail moth (*Euproctis chrysorrhœa*). This insect is found in parts of New England and in Nova Scotia, its favorite food plants being the apple, pear and oak. The insects make conspicuous hibernating nests, which are readily seen and may be collected and burned during the winter. The caterpillars usually hatch in August, and at that time are easily destroyed by arsenical poisons.

Climbing cut-worms. There are a great many members of this family, some of them nearly 2 inches in length. They live in the soil and usually come out at night and climb even to the tops of high trees to feed on the foliage, retiring before daylight. They attack apples, pears, cherries, peaches, blackberries, raspberries, currants and other plants. From five hundred to eight hundred have been counted going up a twelve-year-old apple tree in one night. They may strip the foliage during the two or three weeks in which they are feeding most actively. They are most common on light soils for they do not like to live in heavy soils.

Clean cultivation tends to check their growth, especially if it is maintained well into July. Banding the trees or placing a collar of cotton batting or wool around the trunks will prevent their ascent. Chickens in the orchard will destroy many of them. Where they become too numerous, they may be poisoned with a mixture of bran, 25 pounds and paris green or white arsenic, 2 pounds. This may be made into a soft mash with water or molasses. If this is used, stock and poultry should be kept out of the orchard.

Oyster-shell scale (*Mytilaspis pomorum*). This insect is one of the most commonly distributed of all. It is readily recognized by its peculiar shape and color, resembling a miniature, elongated-curved oyster shell, dark brownish bark-like in color. The eggs are laid by the mother under her shell. These hatch during May to June in the North. They move around for a few hours and settle down, inserting the thread-like sucking tube into the bark to secure food. Egg laying may begin in August or it may be delayed until October. There is usually but one generation in the North; in the southern portions of New Jersey and Pennsylvania there are two. These insects attack apples, quince, plum, raspberry, currants, figs and many other trees. Sometimes they will move onto the fruit.

A number of birds and insects prey upon them. The most satisfactory treatment is spraying about the time the young scales have hatched and while they are crawling during the month of June, using Blackleaf 40, 1 pint to 100 gallons, with 6 pounds of soap or the standard formula of kerosene emulsion. Further South where there are two generations, spraying in August or September is usually advised. Thorough dormant sprayings of lime sulphur will aid in reducing their numbers.

San José scale (*Aspidiotus perniciosus*). This insect is widely distributed and attacks a large number of trees, including most of the fruits of the temperate zone. It lives on the trunk, branches, leaves and fruits. Close examination will reveal a yellowish insect protected by a circular scale-like covering. The insects suck the sap and sometimes are so numerous that there is merely beak room. Generations will pile on generations on the trunks of trees. They are distributed on nursery stock, but the greater care exercised by nurserymen and the fumigation of the stock have checked this means of distribution. As spraying is now better understood the insect is not as alarming as it once was. There are many parasites which prey upon it, as well as ladybird beetles and other insects which devour it. If a scale be removed from a branch or fruit, a red discoloration will remain on the spot occupied.

The present means of control is by spraying, either with miscible oils or prepared oil sprays, as scalecide, which are usually diluted about 1 to 10 or 1 to 15. These sprays, owing to their penetrative power and spreading ability have found much favor where the insect was once more or less difficult to control as on rough-bark trees, in the southern fruit sections. These should not be applied when the temperature is below 40° F. or is apt to fall below 40° F. before the spraying material dries. Lime sulphur is an effective spray, usually being used 1 gallon of standard lime sulphur solution, 33° Baumé, to 8 of water. Spraying is usually made as late as possible in the spring, so that it may be of value for controlling other troubles than San José scale only. The home-made red engine oil sprays are promising.

Crude oil spray. In some cases, crude oil has been used with more or less success, but in many cases there has been serious injury due to putting on too much and putting it on too early in the season. It should never be applied until the tree is ready to start into growth, and when the days are warm; and it should be put on in very limited quantities so that when it spreads it covers the trunk and branches with a film and not so much as to run down to the roots. It is extremely important that the spraying should be thorough—for all of the insects must be hit with the spray material in order to destroy them. Probably the San José scale has been of more benefit to fruit growing than any other insect, because it taught the necessity of thorough work in spraying.

The scurfy scale (*Chionaspis furfura*) is one of the common scales and is found throughout the United States on apple, peach, pear, quince, currant, black raspberry and other plants. It is recognized by the flat, somewhat pear-shaped scales about one-eighth inch long, which sometimes give the bark an ashy or scurvy appearance, hence the name. In the northern region, there is one brood; from Delaware to Illinois, southward, there are two. Remedial treatment as for oyster-shell scale.

Putnam's scale (*Aspidiotus ancylus*). At first sight this may be mistaken for San José scale. It can be readily distinguished from it and may be handled the same as the San José.

Greedy scale (*Aspidiotus rapax*). This is now abundant in California and as far southeast as Florida. It attacks the apple, pear, orange and other fruits. Treatment is the same as for San José scale.

Leaf-hoppers. The apple leaf-hopper (*Empoasca mali*), attacks the foliage of the apple, currant, raspberry, gooseberry and many other plants, sucking the juice and causing the leaves to have a stippled appearance, turn yellow and finally to curl. In Iowa, there are four generations annually. They frequently do considerable damage to trees in the nursery and aid materially in the distribution of fire blight. They are usually controlled by nicotine sprays and dusts.

Flea beetles. There are at least half a dozen varieties of flea beetles which seriously injure young apple trees and those in the nurseries. The best treatment is to coat the foliage with arsenate of lead or bordeaux mixture, or both combined. Bordeaux mixture acts as a repellant, the arsenical as a poison. Dusting with copper-sulphate-lime, with arsenate of lead and nicotine or tobacco dust may be of value.

Green apple bug (*Lygus communis*). This insect has recently done considerable damage in Nova Scotia. It feeds on the apple, pear and quince. It resembles a small yellow aphid in appearance, but is more active. The young begin to emerge several days before the blossoms open, the maximum emergence coinciding with the period of full bloom of the Bartlett pear and as several of the apple blossoms begin to open. They attack the leaves, stems, blossoms and fruit, but principally the blossoms and fruit, and preferably pears. The blossoms, when attacked, shrivel and die. Injured apples drop to the ground, often badly scarred and twisted. The insects often work for a period of a month on the blossoms and young fruits. Spraying with nicotine sulphate just before the blossoms open, and if necessary, just after they fall, 1 pint to 100 gallons, is generally followed. On pears, spraying immediately after bloom is usually sufficient. A heavy drenching, driving spray is necessary so that all parts of the tree are thoroughly coated. This insect has frequently caused the loss of crops of apples when the owners have failed to recognize it.

Clover mite or red spider (*Bryobia pratensis*). This spider-like mite is found throughout Canada and the Northern half of the United States on the foliage of peach, prune, plum, apple, pear, cherry, almond, raspberry and other fruits. Their mouths are fitted for piercing the tissues of the plants and this causes the leaves to assume a yellowish sickly appearance. The most effective control is by thoroughly spraying the hibernating eggs in fall or early spring with miscible oils or lime sulphur, the same strength as used against scale. If the foliage must be treated, whaleoil soap solution, 1 pound to 10 gallons of water, a wettable sulphur spray or dusting with sulphur and hydrated lime, or sulphur alone when the temperature is 80° F. or over, is advised. Nicotine dusts are usually effective. Three per cent nicotine dust will control, if conditions are favorable.

Twig girdler and twig pruner. Both of these insects cause twigs to drop to the ground in which they have placed their eggs. Gathering these twigs and burning them will keep the insects under control.

Pear-leaf blister mite (*Eriophyes pyri*). The leaves of apples and pears are often disfigured by reddish blisters which later turn brown. These are caused by colonies of small mites. In recent years they have become a serious menace in the Eastern states and Canada, on both apple and pear trees. The leaves finally turn yellow and fall, thus weakening the trees. Spraying with lime sulphur about the time the buds are breaking or until the leaves have reached the size of a mouse's ear, the strength usually used for San José scale, will control, although if used 1:15 it may be strong enough to control the blister-mite. At this time, the mites are hatched and moving to enter the young foliage; others prefer fall spraying as soon as the leaves are off, using miscible oil 1 to 10. This is probably best.

Apple aphids. There are three species of aphids, which look much alike and are common on apples. The Apple Bud-aphis (*Siphocoryne avenæ*); the Rosy Apple-aphis (*Aphis sorbi*) and the Apple Leaf-aphis (*Aphis pomi*). The eggs are minute, glossy and ebony-black and may be seen on the twigs of apple trees, lying among the hairs and in the small crevices and cups around the buds. These are barely visible to the naked eye. They have an egg-like appearance under the microscope or magnifying glass. The eggs of the rosy aphis are laid freely on the trunk and larger branches, and those of the apple leaf-aphis on terminal growths and on watersprouts when these are available. The eggs of the apple bud- or grain-aphis hatch earliest, in New York and Ohio early in April in a normal year; those of the apple leaf-aphis and rosy aphis a few days later. The so-called stem-mothers which hatch from the eggs are quite busy producing young in great numbers by a budding process as soon as the leaves expand.

How the aphis live. The aphis suck their food from the sap of the tree. They insert their beak-like tube into the tissues of the tree and secrete an enzyme which predigests their food. The chief damage done to the tree is not what they take from it, but is due to what they put in it, for this enzyme thoroughly disorganizes the plant's activities, causing it to become partially paralyzed and stunted.

The lice cause curling of the leaves; they cover the foliage with a sticky honey dew in which a black or sooty fungus flourishes, and in which fire-blight germs can live.

The Grain aphis, after passing through three or four generations, leave the apple in late May or early June and pass to the grain fields, and do not return to the apple trees until late fall, for egg laying. There may be thirteen generations in a season.

The Apple-Leaf aphis passes through seven or more generations in a season, and lives on the apple tree its entire life.

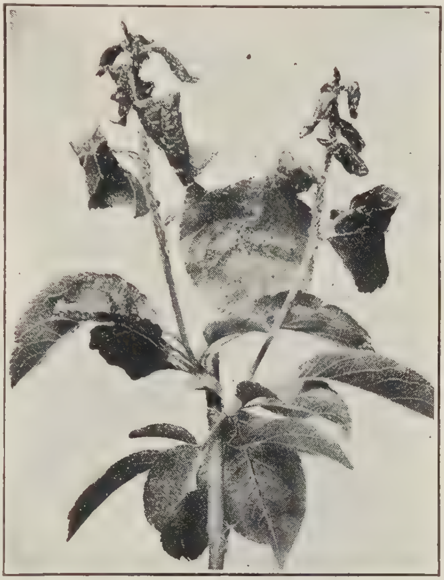


Fig. 39. Apple Aphis on shoots
U. S. D. A.

The Rosy aphis is the worst pest of the three. After three generations on the apple it passes usually some time in June or July to other plants and returns to the apple in September and lays its eggs in October and November.

Structure of an aphid egg. The shell of an aphid egg consists of three layers; an outer semi-transparent and brittle cover, a middle glossy-black elastic layer, and an innermost thin, fragile transparent layer, which envelops the embryo. Near the time of hatching, the outer cover cracks along the middle of the back from two to eight days before the middle layer splits. At a temperature of 30 to 40°F. which is the usual one prevailing at this time, it may remain in this condition for eight days; if hotter, it may be but two days. The embryo likewise is passing through a critical period at this time, and an insecticidal spray will destroy a large proportion of the eggs which would be uninjured by sprays during fall and mid-winter.

Spraying to destroy eggs. Lime sulphur, 33° Baumé diluted one to eight, or one to nine, will kill 85 to 100 per cent of the living eggs if applied while they are hatching. The addition of Blackleaf 40, one to 500, will make the destruction of living aphis more sure but has little effect on eggs. Crude carbolic acid two parts to 98 parts of water, plus

2 pounds of soap to 50 gallons of water will destroy 93 to 100 per cent of the eggs. Sodium hydroxid or caustic soda has been used, but at present is too costly. Lime sulphur alone, or with nicotine sulphate is one of the promising sprays to control the eggs at the time they are hatching. Scalecide and other miscible oils may be used.

Time to spray. By using the dormant spray made for San José scale somewhat late, the aphis eggs may be caught and destroyed. The spray is applied as the first aphis eggs are hatching, usually giving a week for the spraying. If aphids are abundant at the time of the codling moth spray, nicotine sulphate may be added to this spray; that is, 1 gallon lime sulphur in 40 to 50 gallons of water, 2 pounds to 2½ pounds of arsenate of lead paste and one-half pint Blackleaf 40. If a separate spraying is necessary the use of nicotine sulphate and soap is advised in the proportion of three-fourths of a pint of Blackleaf 40, 4 pounds of soap and 100 gallons of water. Dusting the trees with hydrated lime will kill the apple bud-aphis, but tobacco dust or nicotine sulphate and lime have proven efficient in controlling all forms.

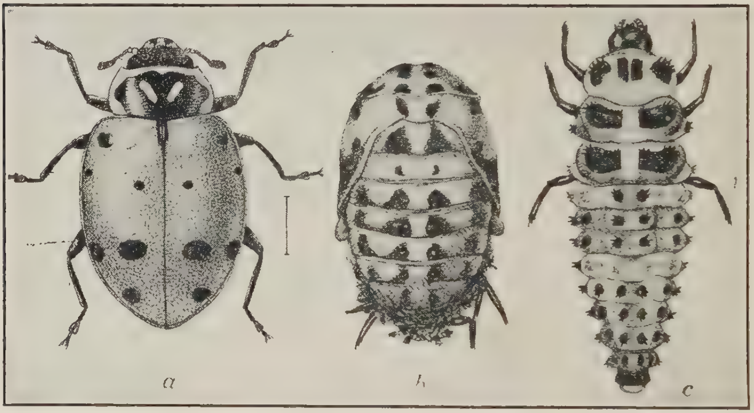


FIG. 40. Convergent ladybird beetle. In all stages this insect is particularly valuable since it feeds on Aphids

For young trees not in bearing, a spray is suggested made up of 60 pounds of stone lime or hydrated lime; 2 to 4 pounds of copper sulphate; three-fourths pint to 1 pint of nicotine sulphate and 100 gallons of water. The lime is slaked to make a good milk-of-lime, the dissolved copper sulphate is added to it and the diluted nicotine is added last. Coating both surfaces of the leaves with this spray, applied through a coarse nozzle, will not only control the attack, but acts as a deterrent against future attacks. Clay in very finely powdered form is also used as a deterrent and is a promising ingredient as a spraying and dusting material.

The woolly aphis (*Schizoneura lanigera*) is distributed throughout the world. It is seen on the trunk, branches, twigs and on the roots as bluish-white cottony masses which are made up of colonies of small reddish-brown lice, each one protected by a woolly mass of long waxy fibers. Those living on the roots do not have as long covering as those found on the tops of the trees. On the roots the aphis cause galls, and on the tops the injured bark fails to heal and the aphis pave the way for cankers. The insect is usually kept under control in well-sprayed orchards, but if it becomes a menace a special spraying with 15 per cent kerosene emulsion during the summer time may be given once or twice. If the aphis be on the roots some benefit has been derived from removing the 3 or 4 inches of surface soil and soaking the soil with scalecide, or kerosene emulsion, 15 per cent. This should be made not later than July. It may injure dormant trees. A coat of tobacco dust is sometimes beneficial. Calcium cyanide has proved efficient. Dipping trees before planting is sometimes practiced but the roots should not be put in lime-sulphur solution strong enough to kill these insects. Miscible oil sprays and scalecide may be used to control this insect. In Australia and South Africa the use of immune root-stocks as Northern Spy and Winter Majetin is practiced.

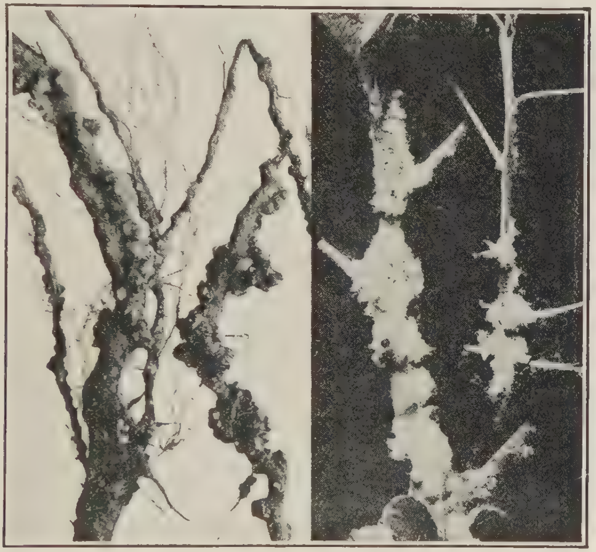


FIG. 41. Woolly Aphis (*Schizoneura lanigera*) on the stems and the galls caused by them on the roots of the apple

Tree-crickets. The Snowy Tree-cricket (*Œcanthus niveus*) sometimes lays its eggs in apples, plums and cherries. The Narrow Winged Tree-cricket (*Œcanthus niveus angusti pennis*), is also an offender in this respect. They frequently do considerable damage in their egg laying, because they pave the way for fire blight and other cankers. The point where the egg is deposited will appear as though affected by a canker. Another species sometimes lays its eggs and causes brown rot infection of peaches. They also attack raspberry canes. Their distribution is quite general over the entire apple-growing region. The chief thing is to prevent their attack by giving clean cultivation, keeping the orchards free from weeds and brush. It is felt by some that the summer applications of arsenicals will have beneficial effect in reducing their numbers.

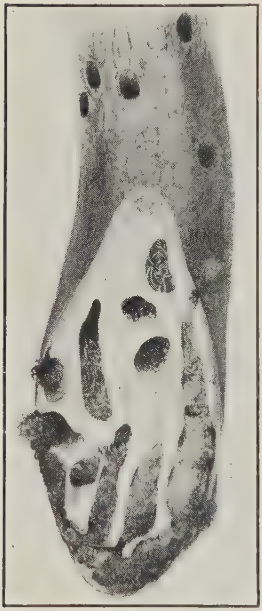


Fig. 42. Advanced work of the apple-tree borer

Apple bud-borer (*Epinotia pyricolana*). The caterpillars of this moth are about one-fourth inch long and attack young apple trees in the nursery and orchard. They mine through the opening terminal bud and for an inch or two into the twigs. They are destructive in the Central states. There are sometimes four broods in a season, the second and third doing the most damage. They may attack the fruit causing an injury similar to that of the codling moth. Destruction of infested twigs in winter is suggested.

Round-headed apple-tree borer (*Saperda candida*). These attack apple and quince and sometimes pear trees. They occur in the northern and eastern portions of the United States and in Canada. The little piles of sawdust-like castings near the base of the tree in spring are evidence of one or more borers in the tree. They work near the base of the tree and on the main roots and sometimes in the trunk. The borer is a fleshy grub about an inch long, light yellow in color, with a dark brown head, and develops when mature into a beetle. Eggs are laid from June to September in the bark, near the ground.

The young larvæ burrow into the tree where they live three years before they emerge as beetles. The usual method is to go over the trees two or three time a year, in May and in autumn and remove the borers. Mounding the trees is sometimes practiced to cause the eggs to be layed higher on the trunk, removing these in autumn. Injecting carbon bisulphide into the hole and plugging it with grafting wax may be one of the easiest ways of destroying the borers and it saves cutting the bark.

The spotted apple-tree borer (*Saperda cretata*) is controlled in the same way. The flat-headed apple-tree borer (*Chrysobothris femorata*) is distributed throughout the United States and Canada. It attacks apple, quince, pear, peach, pecan, plum and apricot trees, and currant bushes, as well as many shade trees. The borer is recognized by its flat head. A single borer may often girdle and kill a small tree. It lives but one year in the tree. It is attacked by many parasites. It is easily detected and can be removed. Tarred paper tied around the tree tightly will deter egg laying of all borers. Caustic potash or washing soda made into a paint-like solution with a pint of crude carbolic acid to every 10 gallons may be used as a deterrent, and two or three paintings of the trunk may be made during May to July. Giving clean cultivation and keeping the trees growing is a good preventive for all borers. Keep weeds away from the base of the tree. In California, the big-headed borer, (*Chrysobothris mali*) is injurious and is controlled as above described.

CHAPTER XVII

COMMON DISEASES OF THE APPLE

Scab (*Venturia inaequalis*) is frequently spoken of in Nova Scotia as Black Spot. The same name is applied to it in Australia and South Africa. The disease is found all over the United States, but is most destructive in the northern tier of states and in Southern Canada. The disease affects the leaves, flowers and fruit, is usually first seen on the under surface of the leaf as a brownish spot which later turns dark in color. The leaf is frequently killed. The blossoms and the stalks carrying the disease may be attacked, causing the blossoms to fall off.

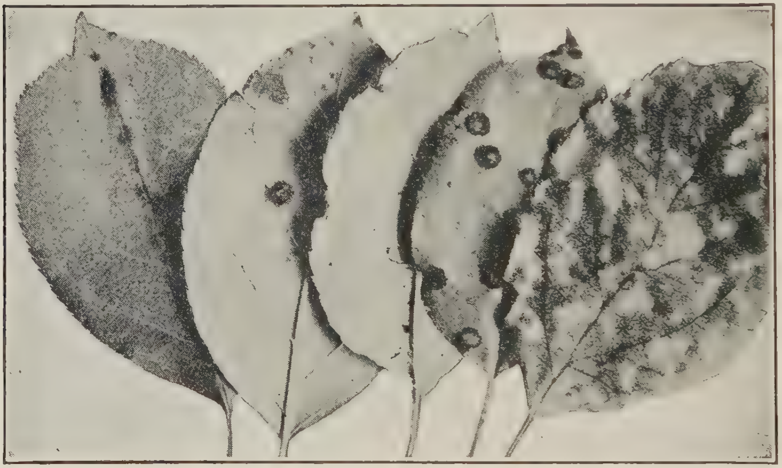


FIG. 43. Apple Scab on the foliage showing the upper and lower surfaces of the leaves *Professor Whetzel*

The appearance of the scab on the fruit is well known. The infection takes place largely in the spring, when the apples are small. In wet seasons it may take place any time during the summer or fall. The scab spots tend to dwarf the apple on the side where they occur. The disease passes the winter in the fallen foliage. The spores are distributed in the early spring from the infected leaves and attack the newly opening foliage buds. The spores are distributed freely in showery weather when there is opportunity for them to develop. In some varieties of fruit the disease is found living on the twigs. It is chiefly a field disease but a type of scab may develop on fruit in storage, the latter type is usually sooty and when this is removed it leaves a hard brown scab-like spot on the apple.

Control is: (1) Destroy all fallen leaves. (2) Spray with bordeaux mixture or lime sulphur just before the blossoms open and after the blossoms fall, and perhaps seven days to two weeks later if weather conditions are favorable for scab. Later sprayings at intervals of ten to fourteen days may be necessary. It is important that the spraying be made before a rain if possible, in order that the fruit may be coated with the protective covering when the rain occurs. (3) Dust with sulphur or "Sanders" copper sulphate-lime mixture or other fungicides.

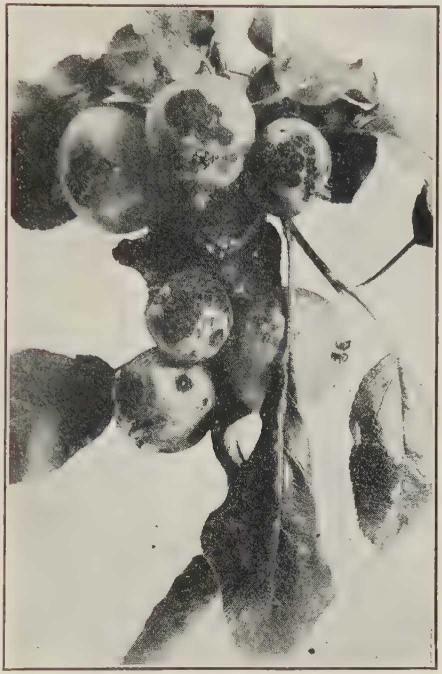


FIG. 44. Apple Scab on fruit and foliage
Professor Whetzel

A variety regarded as relatively resistant to scab in one season may be badly affected the next; even Baldwin, which is classed as resistant, may show 98 per cent scab infection under certain conditions, while Rhode Island Greening regarded as susceptible, may show more resistance than Baldwin. Scab reduces the set of fruit, injures the foliage, reduces the size of the fruit and its quality, and injures its keeping qualities, paving the way for the entrance of pink-rot and other storage troubles. It is usually advised to give three to six sprayings during the season, two prior to bloom and four after. When dust is used, with varieties such as McIntosh, which is particularly susceptible to scab in Western New York, the author found it necessary to dust every week for three months of the growing season in order to keep the crop clean. This was in a particularly wet season and the crop grown was 99 per cent extra fancy. Spraying and dusting are insurance. There is no use trying to take out insurance after the damage is done.

Bitter rot (*Glomerella cingulata*). This disease is usually most prevalent through the Central states, from southern Pennsylvania and Virginia westward. It attacks the trees and injures the fruit. Varieties show varying degrees of susceptibility. Thus Ben Davis and Newtown are listed as susceptible in some sections. Winesap, York and Grimes show resistance. The disease may appear on the fruit at any time from June to October. In the beginning it appears as a small light-brown discoloration beneath the skin, which soon becomes dark brown, causing the surface to sink and show a rotted area, which finally breaks open. Some varieties as Jonathan show trunk injury, cankers being common. Fruits which have been attacked may hang for a year and be a source of infection; or the fruits may be infected from the fungus which has lived in the cankers in the bark. The disease spreads rapidly in warm, moist seasons. In cool, dry summers, it may not be prevalent. This disease may be on the fruit and yet not be apparent at packing time. If the fruit is placed immediately in cold storage and held at 32° F. it may not develop, but if there is delay in cooling the temperature to 32° F., it may develop rapidly. Once it has started it may destroy the value of the fruit.

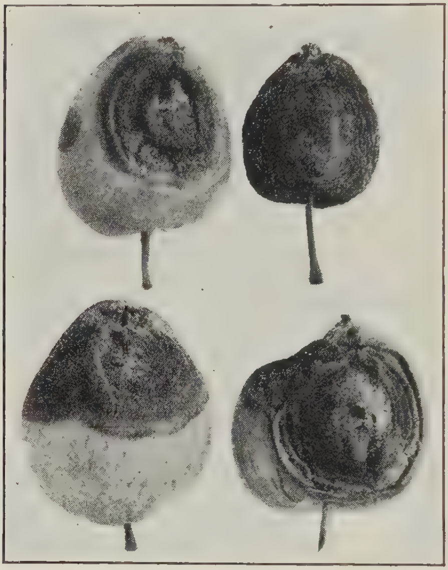


FIG. 45. Bitter-rot of apples, on the fruit

The control is to remove all cankers and spray at least once before the buds open and again after the fruits have set, making perhaps two, three or more sprayings with bordeaux mixture, 4:4:50. Lime-sulphur is non-effective.

Fire blight (*Bacillus amylovorus*). This bacterial disease attacks many fruits—pear, quince, plum, apricot as well as the apple. The control is in removal of the affected twig or portion of the bark, and washing the cut surface and the tool with a freshly made mixture of cyanide of mercury and corrosive sublimate 1 part of each to 500 of glycerine and water and applying a wound dressing to the cut surface. The cankers which live through the winter on the wood should be cut out during the winter months. In removing affected twigs make the cut 12 inches below the diseased area, in healthy wood.

Bitter pit or stippen is a physiological trouble, sometimes causing the breakdown of certain cells in the apple, causing the appearance of dark-colored spots beneath the skin. This is most frequently seen in seasons of fluctuating rainfall and in orchards which are most easily injured by a lack of uniformity in water supply. It is frequently a serious handicap because the injured fruits must be sold at once. It is advised to arrange the care of the orchard so that there will not be any sudden stimulations or checks of growth, and to take care that fruit is stored at temperatures of 30 to 32° F. in a relatively dry atmosphere. The trouble may develop on the fruit in storage. A temperature of 34° F. allows development to proceed. One of the marked disadvantages of common storage is that low temperatures cannot be quickly secured or maintained, and maturation of fruit proceeds rapidly.

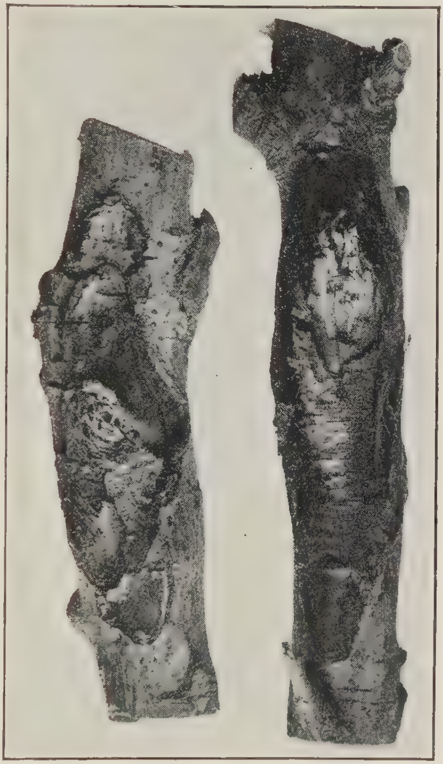


FIG. 46. Bitter-rot cankers on the apple

Black rot canker (*Physalospora cydoniæ*) is regarded as second to scab in importance in Northeastern America, Southeastern Canada and the Middle Western states. It affects the fruit, causing it to rot. Ripe fruits are more commonly attacked than green. The rot starts as a brown discoloration; finally the fruit turns black, hence the name. It also attacks the leaves, causing discolored areas which may attain a diameter of one-eighth inch. This appears as a purplish speck which later becomes yellowish-brown with a grayish-brown center. Hence the name "Frog-eye." Sometimes half an orchard has been killed before the owner realized the cause of the trouble. The wood of Twenty Ounce is particularly susceptible, while the foliage of Ben Davis, Black Twig, Baldwin, Rhode Island Greening and Twenty Ounce is quite susceptible to the leaf spot.

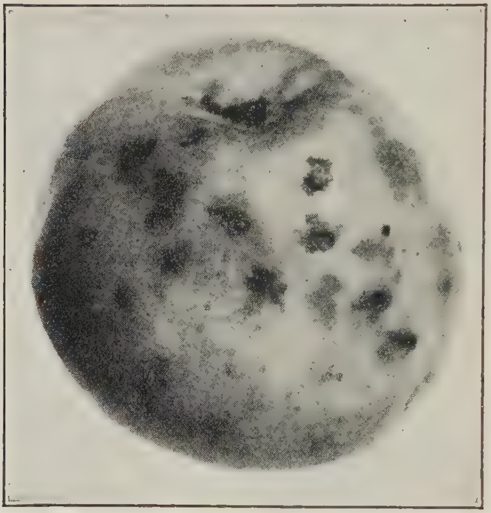


FIG. 47. Stippen or Bitter-pit spots on the apple
Courtesy of Professor Whetzel

The disease passes the winter in the canker on the apple and a great many other trees. The spores are liberated in spring from the cankers and reach the leaves and fruit, insects aiding in the distribution of the fungus. Treatment of the cankers, and the protection of the heart wood from decay with asphaltum paint or coal tar are helpful. Spraying with bordeaux mixture the middle of July when the disease is appearing, and two weeks later, in addition to the prepink, and calyx sprayings, is advised. Careful handling of the fruit may reduce the loss in storage.

Apple blotch (*Phyllosticta solitaria*) is most prevalent in the Central Mississippi Valley, especially on unsprayed orchards in varieties, such as Ben Davis, Missouri and Limbertwig. The disease shows on the fruit when it is six or eight weeks old as small light-brown specks. These enlarge and in some cases the skin cracks. It also attacks the spurs, twigs and shoots, forming cankers. It attacks the leaves and may cause the foliage to drop off prematurely. It is caused by a fungus which hibernates in the cankers and is distributed from same by the wind, insects, rain and by means of spores which attack the new leaves, fruits and twigs in spring. In the Middle West and South West, apply bordeaux mixture, 3:4:50 three weeks after the blossoms fall, giving another application two to four weeks later and perhaps a third. If the trees are sprayed for bitter rot, one spraying will do for both.

Sooty-blotch and fly-speck (*Leptothyrium pomi*) is most common on the lighter-colored varieties of apples such as Rhode Island Greening and Rome, although it is found on Baldwin and Northern Spy; also on pears, particularly Anjou and Lawrence. It is relatively common along the Atlantic seaboard and as far west as Nebraska. The names describe the appearance of the disease. The blotches become abundant in July and August. Color is a sooty brown or black, and in the case of the sooty-blotch it appears as a cloud, while in the case of the fly-speck form, the name aptly describes the appearance. Usually, if the sprayings advised for scab be given and the treatment be maintained through July and August these diseases will be controlled. These troubles are not so common in orchards well located and having good air drainage.

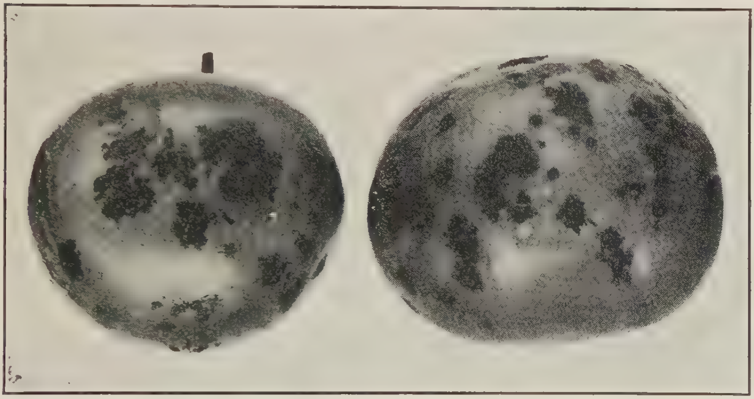


FIG. 48. Apple blotch, early stage; often termed Bitter-rot in the Mississippi Valley where it does considerable damage. While not Bitter-rot it is sometimes worse in its ravages

Professor Whetzel

Fruit spot (*Phoma pomi*) is a typical fruit spot which is different from the Stippen or Dry Rot. It is sometimes seen on the Baldwin, Tolman, Yellow Bellflower. Similar spots are seen on other fruits. The spotting is more or less common through

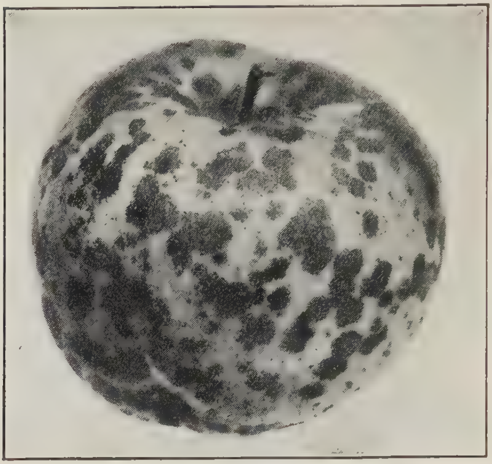


FIG. 49. Sooty Blotch on apple
Professor Whetzel

the eastern part of the United States. These spots do not extend very far into the pulp of the apple, consisting mainly of discolored skin, which is brown and corky; or in the beginning it may appear as reddish spots which later turn brown. These spots do not appear to increase in size if the fruit is held in cold storage. The cause of the trouble is a fungus which usually is distributed during July or early August. The fungus enters the fruit from a stomata or breathing pore in which it may remain apparently harmless for nearly two months before it makes its presence manifest. The disease may develop rapidly in storage or when the fruit goes to market. The disease is usually controlled by spraying with a fungicide, once about the last of June and once later in July. Dusting may control equally well.

Soft rot or blue mold (*Penicillium expansum*). The name Soft Rot describes this common disease which is one of the most ruinous and destructive of our fungus troubles. Anyone who has fruit

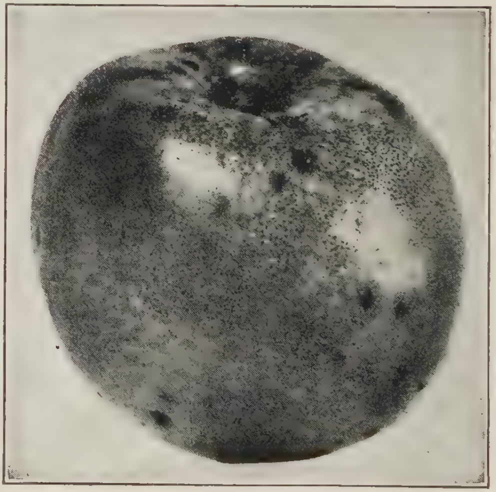


FIG. 50. The Fly-Speck type of Sooty Blotch on the apple
Professor Whetzel

rotting from this disease will recognize it by the odor. The rotten area is very soft, watery, and may be yellowish-brown in color. It is a rot which primarily attacks ripe apples and does not usually affect green fruits. The bluish or greenish mold usually develops over the diseased area. The cause is a fungus, the spores of which are abundant in the air almost everywhere. If one falls into a wound, it germinates and proceeds to develop: so that the disease is a secondary one. It gains its entrance through fingernail cuts, bruises, worm holes, scab and spray injury; in fact any injury may pave the way for it. The method of control is to prevent wounds or injury to the skin.

Pink rot (*Cephalothecium roseum*) is caused by a fungus which is present in the atmosphere and may develop in the wound of a ripe or nearly ripe apple, pear, quince, grape or plum; on apples, pink-rot makes its attacks almost exclusively through scab spots. If apples be held at 32° F. the disease does not develop, but it may do so rapidly when brought out of storage. It is essential therefore that the skin of the fruit be kept intact and free from scab by spraying and that fruit receive careful handling.

Spongy dry-rot (*Volutella fructi*) is seen in the Eastern United States and is caused by a fungus which attacks the fruit, causing the tissues to become spongy and dry. Orchards which are carefully sprayed are not apt to show much of this disease.

Hypochnus leaf-blight (*Hypochnus ochroleuca*). This disease attacks the leaves of apples and the twigs, causing them to look as though attacked by fire blight. It occurs throughout the Southeastern United States. Its work may be distinguished from fire blight in that the leaves usually droop and are matted together and upon them the disease is apt to grow as small cinnamon-brown bodies. Later the leaves fall. Spraying with bordeaux mixture before the buds open and again before the blossoms open will usually control.

Jonathan spot. Such apples as Jonathan, Spitzenburg, Wealthy, Wolf River and some others are affected by a spot which develops markedly in storage and in transit—especially while fruit is in transit from the Western states. The spots may show on the fruits on the tree. At this time, they appear to be quite superficial. Their cause is not known, but they appear to be more prevalent following dry summers, and when fruit is held in common storage instead of cold storage, previous to shipment. Poor storage ventilation, relatively high temperatures and sweating of fruit cause it to develop rapidly. Fruit which is overripe before harvesting is more apt to show it than other fruit picked at maturity and stored promptly.

American brown-rot (*Sclerotinia cinerea*) is quite common in Europe, and must not be confused with Black Rot. Affected apples may become either brown or black. In storage, the black form is common. The disease is common on summer varieties. The fungus may attack stone as well as the pome fruits, causing the characteristic Brown Rot. The fruit may become infected while on the tree, showing smooth brownish discolorations in the skin. It finally covers the entire surface of the fruit. On inspection it will be found that the whole fruit is rotted. Apples affected with Brown Rot do not shrivel greatly, while those affected with Black Rot shrivel rapidly. It is held that fruit adequately sprayed for apple scab will not suffer from Brown Rot.

Cedar rust (*Gymnosporangium juniperi-virginianæ*) passes part of its life on the red cedar, the Virginia Juniper. If these trees are not present, there is no apple rust. The eradication of the red cedars within a radius of at least 2 miles from an apple orchard eliminates the disease. York is very susceptible to it as also are Rome, Wealthy, Jonathan and Ben Davis. Varieties as Newtown, Yellow Transparent, Grimes, Stayman, Winesap and Mammoth Black Twig appear to be resistant to it. The disease is carried over on the cedar by means of cedar apples. It is transferred from these in spring to the apple trees. If the cedars cannot be destroyed resistant varieties should be planted. Spraying with lime sulphur and sulphur paste have been used with variable results, but the best thing is to remove the cedars.

Powdery mildew (*Podosphæra leucotricha*) affects the apple, pear, quince, plum, juneberry, etc., and is quite common in the nursery. It is prevalent in orchards along the Pacific Coast, particularly in the Pajaro Valley of California. It is also sometimes destructive in the Eastern states, Newtown and Bellflower being quite susceptible to injury, as well as Spitzenburg, Rome and Gravenstein. The leaves and twigs are usually affected and the trees may fail to produce blossom buds. A whitish or grayish powder is seen on the under surface of the leaf which finally causes the leaves to crinkle and become stunted. The mildew appears on the upper surface of the foliage and covers the twigs although it does not appear to affect the fruit of the tree at the time. Sulphur and sulphur compounds are the best means of control. The most satisfactory spray is lime sulphur, 1 gallon to 50 gallons of water, to which 3 pounds of iron sulphate are added. Two or three sprayings may be required if the disease is serious. If it comes late in the season one may be enough.

Water core is found in every apple-growing territory, being most common in arid and semi-arid regions, on fruit which is grown in the shaded portion of the tree. It may occur on trees which are growing vigorously, on those which have an excessive water supply and on those which have been defoliated. It is prevented by maintaining uniform conditions of water supply throughout the growing season. Water-cored fruit, if stored in a cool storage at an even temperature, may entirely return to normal.

European canker (*Nectria galligena*) is quite serious in Europe and is found in the Northeastern portions of the United States and on the Pacific Coast. It attacks a great many plants, including pear, quince, cherry, gooseberry and hazel and is increasing in importance. Control as for black-rot canker.

Superficial bark-canker (*Myxosporium corticolum*) is seen on apples and pears in the Northeastern states, and is sometimes confused with black-rot canker. The disease never enters the cambium layer. It is mentioned here merely that the grower may know that it exists and is not so serious as the black-rot canker.

White-heart rot (*Fomes igniarius*). This fungus disease sometimes passes from the forest, where it is relatively common, to the apple orchard, causing rots to start in wounds. The aim should be to prevent access of the fungus by avoiding wounds and covering them if they are made, and the removal of dead branches as soon as discovered.

Blister-canker (*Nummularia discreta*). This fungus disease is difficult to control. It grows rapidly in the heart wood, once it secures an entrance. It cannot get into the bark except through injured tissue. If promptly removed, it may be kept under control.

Northwestern anthracnose (*Neofabræa malicorticis*), often called Pacific Coast canker, or Northwestern apple-tree anthracnose, is more or less common in Washington, Oregon and in British Columbia. In some places it is second in importance only to scab. It is most serious in regions where there is abundant rainfall. Symptoms are characteristic dark sunken dead areas in the bark, hence the name Black Canker or dead spot. These are usually abundant on the younger branches. They are usually noticed during November and December, although they develop throughout the winter. The following spring they become larger and the surface of the bark may sink. The cankers may appear in long, narrow strips, or they may girdle the branch. The disease attacks the fruit, causing it to rot. Fruit may be apparently sound when packed but rot in transit. Spraying the trees with bordeaux mixture after the fruit is harvested, 6:6:50, and again in two or three weeks' time, and taking care to coat the limbs thoroughly, removing all cankers, will probably clean up the trouble. To attempt the removal of a large number of cankers from badly infected trees is a large undertaking.

Rough-bark (*Phomopsis mali*), or Rough Bark Canker has been recognized on Newtown in Virginia, and York and Winesap, and is found on both apples and pears in California. The fungus disease attacks the bark, forming cankers. No spraying methods have been developed.

Rosette. In Colorado, California and Idaho the rosette attacks apples, causing a disease similar to Rosette of the peach, in which the small leaves grow in tufts or rosettes at the ends of the branches. It is most common on trees which are shallow rooted, because they cannot penetrate the subsoil.

It is one of a number of functional disorders which show that the tree is suffering from malnutrition. Other troubles of a similar nature have been recorded as "litttle leaf," "dieback," "fruit pit," most of which have been overcome by more intelligent care of the tree. The trees need feeding. Irrigation, manure, nitrogenous fertilizers, sowing the orchard to alfalfa and clover, bringing in organic matter and nitrogen have all proven beneficial. Incidentally, the mowing of alfalfa and clover in irrigated orchards, using the crop as hay for feeding horses and cattle is regarded as a dangerous practice where thorough spraying is carried on.

Crown-gall (*Bacterium tumefaciens*). Crown-Gall, Hairy-Root and Root-Gall may be seen on nursery stock. Some varieties of apple trees show more than others. The knot-like rooting habit, which may be taken for hairy-root, may be an inherited tree character. Galls may appear on the trunk and branches as well as the roots and yet the trees remain profitable to a good old age. Buds or grafts taken from such trees transmit the gall-producing character to both roots and branches of the new trees. In such varieties root-galls and hairy-root do not appear to be any detriment, on the contrary, they are a characteristic of the variety. At present all forms of root-gall are spoken of collectively. Trees showing root-galls in which bacteria are present are found distributed throughout the world, but are most abundant in the Southern part of the United States from Virginia to Texas. They are known in Canada. Root-galls appear to be more common on root-grafted than upon budded trees. They are most common on grafts which have been carelessly made and on those which have been tied by string instead of

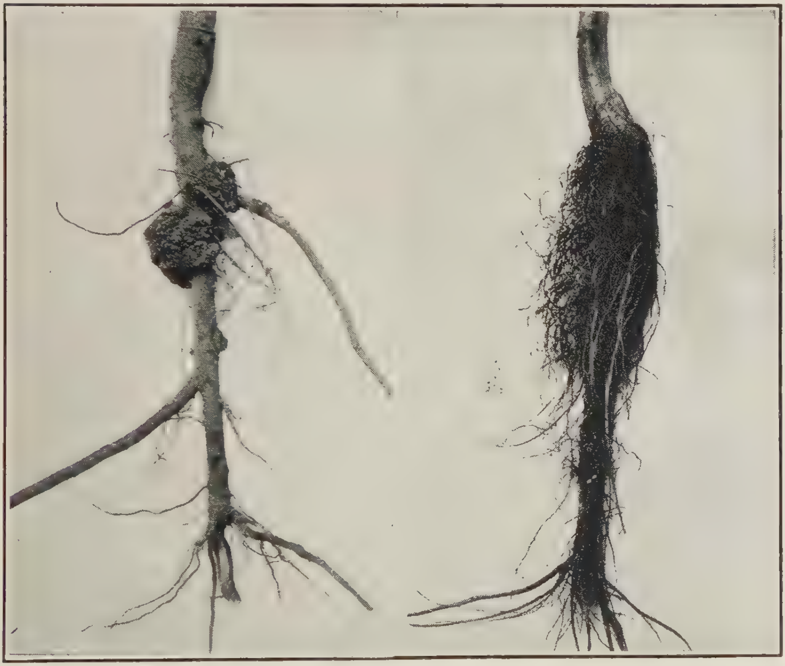


FIG. 51. Root gall and Hairy Root on the apple are considered to be different forms of the same disease. Trees so infected are not considered desirable for planting. The disease causes little or no damage to the tree in some places and the probability of infection after planting in the orchard is so great that the wisdom of discarding strong trees showing these growths is now being questioned

tape. Such may be simply an attempt on the part of the plant to throw out a callus to cover the wounded area. In some cases there are no ill effects; in others the plants appear to be dwarfed; and in still other cases, the gall may become infected by bacteria.

The evidence indicates that where bacteria are present the disease is a true plant cancer and can be transferred to low temperature animals, such as fish, producing growths which are recognized as carcinoma or cancers. The bacteria causing this trouble will enter the plant through a wound. They may be carried by irrigation waters; they may be transferred by using scions or cuttings from diseased plants, by the pruning knife or the grafting knife, and by insects. When they invade the cell they stimulate it into excessive activity, resulting in the galls which are apparent. Galls are found on a large number of plants: almond, apricot, cherry, clover, cotton, English walnut, grapes, peach, plum, prune, quince, tomato, turnip, etc.

Certain state officials contend that trees which show root-galls of any kind should not be planted. In certain parts of the United States, from Pennsylvania southward and westward, the evil results from planting trees infected by gall-producing bacteria seem to be proven in at least some instances, but further north there are trees which were root-galled when planted, and such have made satisfactory growth. The whole problem is being re-investigated and it is now recognized that the present system of inspection and destruction of trees is unwarranted.

Root-rots of fruit trees. These diseases are caused by fungi which live on the roots of fruit and other kinds of trees. They may cause heavy loss. In one case 8 per cent of the trees in a large prune orchard died each year for seven consecutive years on account of mushroom root-rot. The presence of these diseases may not be suspected until one or more trees shows a lack of growth and yellowing or wilting of the foliage. Upon examination of the crown below the surface it is found that it has been girdled and that the roots are likewise affected by a rot, the tree being practically dead. The infection took place probably one to three years previous. Heavy winds may reveal the trouble, causing the affected tree to blow over. Affected trees usually fail to mature their fruit, due to an inadequate supply of food.

Mushroom root-rot (*Armillaria mellea*) is caused by the honey mushroom, honey-agaric, *Armillaria mellea,* hence the name,—Armillaria root-rot. It occurs in woods, orchards, berry patches and newly cleared land. It lives on dead buried wood from which it spreads to the roots of trees. It is most destructive in Washington. Oregon and California, although it occurs in Missouri, Arkansas and Texas.

Mode of Development. Inspection of an affected tree will reveal in the soil near the affected root, hard black shiny, much-branched strands one-twenty-fifth to one-twelfth of an inch in diameter; hence the name, shoe-string root rot. These strands have a tough texture and a mushroom odor. From these strands or rhizomorphs during the autumn the white-gilled honey-colored mushrooms develop. The disease is spread in two ways: (1) by the strands which travel in the soil from tree to tree, and (2) by means of spores which are liberated from the mature mushroom and are often carried long distances. These fall on the soil, grow, living on the humus, and develop the strands to complete the cycle. Control methods are as follows:

1. In selecting a site, avoid infested land.
2. On suspected soil, grow a non-susceptible crop for at least three years before planting.
3. Destroy the mushrooms.
4. Quarantine diseased trees or remove them. The disease may be spread by the tools moving it through the soil. To quarantine, dig a trench a foot wide and 2 feet deep near the end of the roots of the tree, severing all and throwing the soil toward the tree. Injured trees may be treated in spring or early summer as follows: Expose the roots, remove all diseased wood and bark, and disinfect with corrosive sublimate, 1 to 1,000, and leave them exposed to the air until fall. Paint the wounds with white lead or coal tar and return the soil in the fall.
5. In removing a dead tree be sure that the strands are not distributed during the operation.
6. Do not replant a tree for three or more years on the site where a diseased tree stood, and disinfect the soil with formalin or copper sulphate solution.

Clitocybe root-rot (*Clitocybe parasitica*). Like the Armillaria root-rot. this one affects other plants than the apple, doing considerable damage to the peach and cherry. It is confined to the Southwestern section of the United States. The greatest destruction has been wrought in Oklahoma, where peach and apple orchards have been destroyed by it. It is most apt to be present on lands which have recently been cleared. It is not known on prairie soil. The disease is recognized by the exudation of a gum from the crown of the tree. The leaves turn yellow and wilt. The cause is a fungus, which is the mushroom, the strands of which spread from one point to another through the soil.

Xylaria root-rot is found in the Eastern states, having been observed in New York, Virginia and North Carolina. The common indicators of its presence are: (1) Death of a limb, on the side fed by the dead root. (2) Poor foliage, often one-third normal size. (3) Very short twig growth. (4) Inclination of the trees away from the most seriously infected roots; young trees can be pulled up by hand. And (5) presence of clusters of black, finger-like fungus bodies in the soil near the trunk of the tree.

Texas root-rot (*Ozonium omnivorum*) occurs in the South and Southwest. It is also called the Cotton root-rot, because it affects cotton as well as fruit and forest trees. It is also known as Ozonium root-rot because it is caused by the fungus *Ozonium omnivorum.* It is also found on vegetables, forage crops and weeds. It is most common on black, waxy soils which are poorly aerated. It probably needs a higher temperature than prevails in the North, thus limiting its geographical range. The strands are dirty white or yellow, and are readily broken into segments which are easily washed from place to place. Cultivation aids its distribution.

CHAPTER XVIII

SPRAYERS AND DUSTERS

A number of factors will determine the kind of sprayer to purchase; for instance, if one is located on a hillside as in western Virginia or southern Ohio, or where the land is terraced one row in every four rows of trees to furnish a driveway, and the grade is 10 per cent going diagonally up the side of the hill it is evident that nothing but a small to moderate size machine can be considered, even assuming that the orchard is a commercial venture. On the other hand, if the land is level and the orchard large, a large-size power rig holding 300 to 500 gallons of material may be used. The most recent development along this line is an outfit equipped with a ten-horsepower engine of a marine type. When equipped with a spray gun, the spray can be changed very quickly from a mist to a driving spray. Usually there is no tower, but one man can spray the tree from the ground even if it is of good size. For the largest trees a tower may be useful. The delivery is rapid, and if the material is hauled to the sprayer, from 400 to 600 gallons can be applied per hour.

Whether a large machine is used, or a hand-power pump on a stone-boat with a barrel to hold the liquid, the mechanism remains the same in principle. The best returns usually come from the use of the more powerful machines. The size of the machine will depend, of course, on the amount of work and the kind of spraying to be done. The spraying of trees in city parks demands a very different type of machine from one used for instance on a peach orchard. Some of the machines built for the former purpose are very much like small fire engines in their mode of delivery.

Stationary spraying outfits are seen in commercial orchards both in the East and West. A large tank, often 1,000 gallons capacity, is located on the highest point in the orchard. It is connected with a system of underground pipes, often about 150 feet apart, equipped with standpipes for hose connection. One-inch to 1⅜-inch pipes are used and with a pressure of 300 to 400 pounds one man can spray 2,000 gallons a day.

Hand-power sprayers. One so situated as to be forced to use hand-power instead of gasoline will probably be best served by an upright lever pump. For this kind of sprayer the worker stands upright and works a long lever to and fro to furnish the necessary power. With such a machine two leads of hose can be run. Most of these sprayers are equipped with an air chamber so that a relatively steady pressure is maintained. The man pumping is frequently able to drive the team at the same time. The outfits should have an agitator that the material may be stirred from time to time. Hand agitation by means of a hoe or wooden paddle in the barrel is feasible. The orchardist who grows fruit on a commercial basis is seriously handicapped if conditions make necessary the use of hand-power machines only.

Power sprayers. It is probably true that if one has five acres of good-bearing orchard on level land he cannot afford to be without a power machine. It is estimated that usually one power sprayer is needed for twenty to twenty-five acres; hence the owner of a small orchard is somewhat handicapped in having a higher investment per acre than is usually advised.

Essential parts of a sprayer. The essential parts of such an outfit are: an engine to furnish power and a pump and a tank for holding the liquid. The tank must be equipped with an agitator, a pressure gauge, a tower and the different accessories, such as hose, rods, nozzles, tank filler, etc. The outfit is mounted on a truck.

The engine. The engine must be of sufficient power to operate all of the nozzles and maintain a pressure of 200 to 300 pounds. Two and one-half to three and one-half horsepower engines are usually used, but several sprayers have four to ten horsepower engines. A light-weight engine is preferred to a heavy one. Thus far gasoline is the fuel used. It is important that the engine be of a standard type, capable of adjustment easily, and that it may be operated in all kinds of weather and repairs easily and quickly secured.

The pump. The pumps made are usually furnished with one, two, or three cylinders which may vary in size and capacity. Porcelain-lined cylinders are now on the market. The piston and the cylinder are apt to wear out and from time to time they will need packing. This feature should not be lost sight of in the purchase. The packing should be easily replenished. Pumps equipped with stuffing boxes on the outside are the most easily maintained in repair.

The tank. Tanks are usually made of cypress and they may be square or half-round. The half-round are preferred because they can be readily drawn tight to prevent leaks. The round tank is hooped and tightened just as a silo. The half-round tank is the most common because it usually offers easier facilities for maintaining agitation. In one or two machines metal tanks are used, but in the main wood is used. In both, and in spite of care taken to rinse out the tank after use, there is a tendency for the materials to adhere to the sides and in time form coats which later scale off. This tends to cause trouble in the nozzles.

The agitator. Most spraying materials tend to settle in the tank, thus causing the material which is delivered when the tank is nearly empty to be heavier and markedly different from that which was first applied. Considerable ingenuity has been exercised to maintain agitation so that the product will be uniform throughout the period of spraying. The propellor type of agitator, consisting of a spiral screw which stirs to the bottom of the tank and operated at high speed, is probably the most simple, durable and best. A sliding paddle on the bottom of the tank is not effective while the tank is full. Paddles which swing from a fulcrum or revolve on a crank if sufficiently numerous, are satisfactory. Jet agitators are in use, part of the material being forced back and rising upward from the bottom of the tank; and in some cases air is used to maintain agitation in this way.

The tower. Wherever tall trees are to be sprayed, a tower at least 12 feet from the ground should be used on most spray rigs. It may be built out of 2x4 scantling, or some other strong material. It must be securely fastened to the truck and the operator safeguarded with a guard-rail somewhere about waist high.

Hose. The hose should consist of good six or seven ply, three-eighths, one-half inch or five-eighths in diameter. It should be well made. It is an advantage to have it armored, to add to its life. The man on the tower may need 20 feet and the man on the ground may need 40 feet, and wherever hillside spraying is encountered perhaps 200 feet will be required. Hooks should be arranged on the side of the sprayer so that the hose can be coiled up easily when not in use. It is a waste to have more hose than is required. There is not only waste of material and capital but there is increased friction. The length of hose should be adequate for the man on the ground so that he can get around.

Rods. The rods consist of brass or aluminum tubes which may be enclosed in a bamboo rod. The rods have connections on each end so that the nozzle can be screwed on one and the hose clamped on the other. A stop cock should be placed between the hose and the rod for shutting off the spray when necessary. This should be capable of easy manipulation.

Nozzles. The nozzles are made for special purposes: to throw a direct spray or a funnel-shape mist, large globules of material or very fine. Looking at a nozzle, we may first remove the nozzle cap; under it we find a plate with a hole, varying in size with the type of spray to be applied; the hole may be small or it may be large. Beneath this is a chamber and often a nozzle plate which contains in many instances two openings. Removing this we find a chamber, the eddy chamber, in which the material acquires direction and according to its shape, and the arrangement of the openings either a direct spray or a whirling spray is secured. In some cases the spray consists of a cone, and if it were directed at a plane surface it would present a hollow center bounded by a rim of material.

Nozzles are tested and their work recorded on a spray chart. The nozzle should be of such type that it may be readily cleaned and will not clog easily. Nozzles vary in their efficiency; thus some are built to operate with 100 to 200 pounds pressure and some with less than 100; accordingly they should be purchased for the particular purpose in view. Information regarding these factors is furnished by the different manufacturers. For hand-power outfits nozzles that operate at low pressure should be used. A pressure gauge is a necessity to show the power which is available at the time.

The spray gun. The original spray gun was made of brass, about 18 inches long. A valve shaft extends from the handle through the tube to the head; by turning this shaft the discharge is regulated. It is done by a slight turn of the wrist. The spray may be shortened or widened or shut off with very little work. The most wear come on the disks but these are easily replaced. The discharge can be so regulated that a driving spray can be made which will carry to the top of a tall tree; or the spray may be forced into the form of a fog. A pressure of at least 300 pounds is desirable and 350 pounds are better. Not less than half-inch hose should be used in order to avoid unnecessary resistance. The points claimed for the spray gun are: It saves time, labor and spray material.

Danger of burning or russeting the fruit and foliage may attend its use when the gun is held too close to the tree and the spray is thrown with too much force. There is also a tendency to improperly spray the tops of the trees when the attempt is made to reach them from the ground. The spray gun does not abolish the necessity for a tower in the case of full-grown trees. The ideal spray is a fog, a penetrating mist, and this should be directed downward onto the fruit and foliage so that it coats everything without injuring anything. The thinnest possible film is enough; more is too much and is a waste of material and is apt to do harm. In many cases, where the spray gun has been used, the fruit on the tops of the trees, usually the best in the orchard, is found to be the poorest. Too much has been expected of the gun. It takes brains to use it. When two guns are in use at one time, a ten-horsepower engine is desirable and the modern high power machines are so equipped. The spray gun is designed for use on a high power machine. Poor results will follow its use below 300 pounds pressure. To do good work the pressure must be adequate and the volume ample. A good man should handle 5 to 6 gallons a minute and this volume at adequate pressure should carry to the top of the tree. If the volume has to be reduced in order to secure pressure the results are unsatisfactory. In one test when the pressure gauge showed 325-350 pounds pressure the approximate pressure at the end of the hose was 300-325 pounds, and the pressure at the nozzle about 250 pounds. The discharge is determined by the size of the opening in the disc and in this test with one-sixteenth inch openings the delivery was 1.37 gallons per minute, which is wholly inadequate; a three thirty-second inch disc opening delivered 3.1 gallons; a seven sixty-fourth inch delivered 4.5 gallons, which was a good spray; a one-eighth inch disc gave 5.72 gallons and a nine sixty-fourth gave 6.62 gallons per minute with an overflow in all cases. The volume of the two latter insured a proper spraying of the tops of the trees. An excessive overflow is a waste of power. Usually it requires about four-horsepower to operate one gun properly.

The truck. In most regions the truck can be used. It should be equipped with relatively wide wheels of good size. The front wheels should be made to cut under so that the sprayer can be turned round in a short space. A person purchasing a sprayer should consider not only that it is adapted to his requirements so far as size is concerned but that repairs can be easily and quickly secured, that there is little to get out of order, that it is well enough made so that it does not need constant repairs and that an average man can operate it.

Tank filler. No sprayer is complete without a rapid tank filler. Most orchards are not equipped with water at the most convenient place for filling the tank and it is frequently a decided advantage to have a tank filler attachment on the machine so that should the tank wagon not be used to haul the material to the sprayer the spray crew can fill the sprayer independently. The tank wagon should be equipped with a good pump for emptying the material into the sprayer. Before spraying any material it should be thoroughly agitated in the tank wagon. A thresher-man's pump on the tank operated by hand or a small engine will do the work.

The duster. In Europe, dusters have been in use for at least two generations. The construction of the machine is about the same today as it has been for some time. The introduction of new dusting materials very finely ground has given new life to the project while the rapidity of operation and economy of labor in doing the work has led fruitgrowers to use them. Dusting of field crops as hops, cotton and tobacco is well established. The saving in transportation of water, especially where it has to be hauled considerable distances and up hillsides, has appealed to many, so that dusting is used in many places where spraying heretofore has been half done. Whether the duster will make a place for itself in the West will undoubtedly depend somewhat upon climatic conditions. In the East the dew fastens the dust on the foliage; in the arid regions there is little dew.

The points to consider in the purchase of a machine are: (1) the machine itself; (2) the uniformity of delivery of the material, and (3) the ease in operation and saving in time. The dusting outfit as usually furnished, consists of an engine, generally of two- to five-horsepower, and the duster itself which consists of a hopper which may be dust tight. The upper opening of the duster, however, should be large enough that the materials may be easily emptied into it. It should be equipped with an outlet for delivery of the material and a force feed to insure uniform delivery. In one machine this consists of a shaft carrying brushes which revolve, forcing the material through a perforated plate, the idea being to crush the small particles so that there will be nothing but dust—no lumps will go through. In the discharge pipe the movement of the dust is accelerated

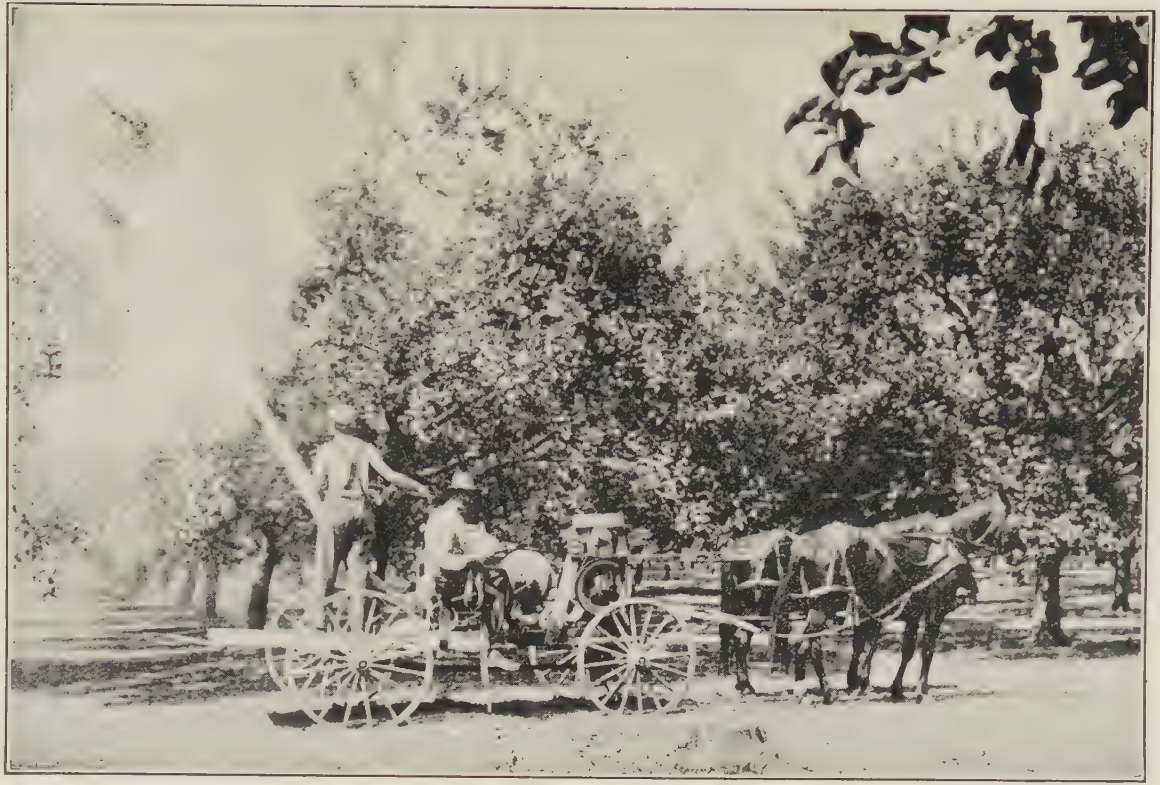


FIG. 52. Dusting the apple orchard in New York State. It is easy to do four acres an hour with such a machine. For best results it is essential that the air be relatively still, a slight drifting of the material is not undesirable, hence early in the morning or late in the evening are preferred for the work

by the air from the blower. This consists of an aluminum fan which revolves rapidly, often 2,000 to 2,500 revolutions a minute. The draft developed by this carries the dust to the mouth of the pipe, from which it emerges as a dense smoke-like cloud. The discharge pipe is usually an ordinary metal pipe, but it may be made of rubber or a metal pipe with a rubber or flexible joint so that it can be moved in any direction. The duster and engine are usually mounted on skids for ease in mounting onto a wagon. Among the points to consider are: (1) that the flow of material shall be uniform, (2) the ease with which the flow of material can be stopped, and (3) the ease with which the delivery pipe may be directed on a particular tree.

The Mixer. For those wishing to mix their own dusting materials specially constructed mixers may be purchased. Common sizes are 100 to 400 pounds capacity.

Combined Mixer and Duster. The California agricultural experiment station in conjunction with certain firms have developed a combined mixer and duster. This was built for applying nicotine dusts, the materials are placed in the hopper and the mixing takes place in the orchard as the material is applied.

CHAPTER XIX

SPRAYING AND DUSTING

There may be said to be three common types of spraying materials:

1. **Fungicides** or materials used to control fungus diseases of plants which fall into two groups:

(a) Those in which copper compounds are the agents, as in bordeaux mixture, copper sulphate—lime dust.

(b) Those in which sulphur, either alone or in combination is the agent, as lime sulphur, self-boiled lime sulphur, wettable sulphur, soluble sulphur, barium sulphur and proprietory combinations sold under trade names. Some of these possess insecticidal value as well as fungicidal.

In using fungicides we aim to prevent disease by coating the branches, foliage and fruit with the material before the arrival of the disease, not to cure the disease after it appears. Fungicides are fungicides to a specific fungus. Each plant is perhaps a unit in its tolerance or immunity. The watermelon wilt can live in a 2 per cent copper sulfate solution but not in a 6 per cent, hence in protecting the stems of watermelons we need a bordeaux paste showing at least 6 per cent copper sulfate. For spraying apple foliage we use a 1 per cent solution or weaker.

2. **Internal insecticides or stomach poisons.** These are used against insects which chew their food and which live on fruit or foliage. The common ingredient now in use is arsenic in some form of combination, that most commonly used being arsenate of lead. Other materials used are calcium arsenate, magnesium arsenate, arsenates of various metals, and sometimes arsenites of various metals and paris green. Hellebore is sometimes used but it contains another poison.

Contact insecticides or external poisons. Among these are: Lime sulphur, fish-oil soap, soluble oils, tobacco extracts as nicotine sulphate and blackleaf 40, and proprietory remedies as scalecide and others. These are used against insects which secure their nourishment through a sucking beak or tube and which do not chew their food as for instance, aphids or the pear psylla. The poisons used in contact sprays may work in different ways to destroy the insect; for example, soaps bring about suffocation of the insect by clogging the openings in the insect's back through which it breathes. Such substances as carbolic acid bring about disorganization or paralysis of the protoplasm in the cells of the insect's body (plasmolysis). The same is probably true of lime sulphur in its action on San José scale. It will be apparent that there is no use applying these remedies unless the insect is present, nor will any benefit be derived unless the insect be hit. The treatment then for this class differs radically from that given for chewing insects, for when controlling the latter, we spread the poison over their food before they eat.

The common material now in use as a contact foliage insecticide is nicotine in some form, as Blackleaf 40 in sprays or tobacco dust or nicotine dust. It may function as a fumigant, thus destroying some of the insects it does not hit. Kerosene has been used as kerosene emulsion and many other ingredients have been tried and the end is not yet.

Preparation of standard bordeaux mixture. Bordeaux mixture is made by mixing 4 pounds copper sulphate (blue vitriol) with 4 to 5 pounds of freshly burned lump lime in 50 gallons of water. The usual procedure is to suspend the copper sulphate in a sack in the top of the water, usually in a wooden vessel and let it gradually dissolve. Slake the lime in another vessel, adding the water gradually to cause the lime to fall to a fine powder and then into a creamy milk of lime. Each of these lots of water may be brought up to 25 gallons. When the two are brought together in the spray tank, strain both to make sure that no sediment enters the spray tank to cause stoppage of the nozzles.

Stock solutions. If any considerable quantity is required, stock solutions are made of both the copper sulphate and the lime. To do this, 80 pounds of copper sulphate are suspended over night in the top of a barrel containing 40 gallons of water; when dissolved each gallon of solution contains 2 pounds of copper sulphate. In another barrel 100 pounds of lump lime are slaked to a powder and water is gradually added to bring the whole to 40 gallons. At this strength, when 4 pounds of copper sulphate are needed, 2 gallons are measured out and when about 5 pounds of lime are required, 2 gallons of milk of lime is removed and the two are put into about 45 gallons of water in the spray tank.

If arsenate of lead is to be added 2 to 3 pounds of the paste or 1 to 1½ pounds of the powder are weighed out and completely mixed with 1 or 2 gallons of water and this poured into the tank. One of the best ways of mixing paste arsenate of lead with water is to churn it in an old up-and-down churn. Powdered arsenate of lead is usually poured into the tank of material while the agitator is running. It is very important to secure an arsenate of lead which stays well in suspension and does not readily settle in the water.

A quicker way to make bordeaux mixture is to purchase the hydrated copper sulphate. This is a fine powder. Pour the required amount of the powder directly into the full tank of the sprayer having the agitator running, and add the required amount of hydrated lime at the same time. A fine bordeaux mixture can be made in this way with little trouble.

Commercial bordeaux mixture. For those using a small amount it does not pay to make bordeaux mixture. It is easier to purchase the prepared material or one of the proprietory remedies. Both paste and powdered bordeaux may be secured.

Calculating values of commercial bordeaux mixture. Since commercial bordeaux mixtures vary widely in copper content, it is necessary for the grower to know their strength in terms of the amount of equivalent copper sulphate in 50 gallons when diluted. This can be easily calculated by the method described in Farmers' Bulletin 994. The only feasible method of complying with the requirements of the Insecticide Act of 1910 in the case of bordeaux mixtures is for the manufacturer to include on his label some such statement as the following:

Active ingredient: Copper .... per cent.
Inert ingredient: .... per cent.

The grower should therefore find on every label of bordeaux mixture a statement of the copper content expressed as a percentage. The first thing necessary is to determine what amount of crystallized copper sulphate would be required to prepare the mixture in question. This can be done very simply by the use of the factor 3.93. Thus, when the percentage of copper (Cu) is given, as it usually is and properly should be in the analysis on the label, multiply this percentage by 3.93.

Example—A commercial bordeaux paste which has been tested in some field experiments contains 5.92 per cent of metallic copper, according to the analysis given on the label. Therefore multiply 5.92 per cent by the factor 3.93 equals 23.27 per cent. Thus, the paste contains copper equivalent to 23.27 per cent crystallized copper sulphate. The label recommends that 8 pounds of this mixture be diluted with 50 gallons of water. Therefore, in order to calculate the amount of crystallized copper sulphate in 50 gallons of the diluted spray, take 23.27 per cent of 8 pounds, which equals 1.86 pounds; thus not being so concentrated as a 2:2:50 bordeaux mixture.

TABLE FOR COMPARISON

Metallic copper declared on label	Equivalent copper sulphate	Pounds of concentrated mixture necessary to add to 50 gallons of water to make formula—			
	Per cent	2-2-50	3-3-50	4-4-50	5-5-50
1.5 per cent	5.89	33.9	50.9	67.8	84.8
2 per cent	7.86	24.5	38.2	50.8	63.6
2.5 per cent	9.82	20.3	30.5	40.7	50.9
3 per cent	11.79	16.9	25.4	22.6	42.4
3.5 per cent	13.75	14.5	21.8	29.1	36.3
4 per cent	15.72	12.7	19.1	25.4	31.8
4.5 per cent	17.68	11.6	16.9	23.6	28.2
5 per cent	19.65	10.2	15.2	20.3	25.4
6 per cent	23.58	8.4	12.7	16.9	21.2
7 per cent	27.51	7.2	10.9	14.5	18.1
8 per cent	31.44	6.3	9.5	12.7	15.9
9 per cent	35.37	5.6	8.4	11.3	14.1
10 per cent	39.3	5.0	7.6	10.2	12.7
11 per cent	43.23	4.6	6.9	9.2	11.5
12 per cent	47.16	4.2	6.3	8.5	10.6

If the formula is not of the strength desired, the grower can determine from the table approximately the number of pounds of the preparation it is necessary to add to 50 gallons of water to make either a 2:2:50, a 3:3:50, a 4:4:50 or a 5:5:50 formula.

Bordeaux injury. Bordeaux mixture when applied under certain atmospheric conditions stimulates the growth of the foliage of certain plants, causing the leaves to be thicker, hence increasing the capacity of the leaf for work. This leads to an increase in crop production; in addition, the plant is protected from the attacks of certain diseases which might lead to loss of both foliage and fruit. Under other atmospheric conditions the same strength of bordeaux mixture will scorch or burn both fruit and foliage until the grower is led to wonder whether the remedy is not more destructive of plant life than is the disease. The large amount of bordeaux injury seen on apples when power sprayers came into use was the cause of the rapid increase in use of lime sulphur, under the impression that at last a substance had been found which would destroy the parasite but would not hurt the host. Such a desirable fungicide has not yet been found. It is therefore important that those using spraying materials realize that they are playing with fire; they must destroy one form of plant life but not hurt the host.

Bordeaux mixture appears to be most injurious to the young apple for about a month after bloom. At this stage, while the apple stands erect it is easily hurt, and it may be unwise to apply bordeaux mixture during this period. Again, with some varieties no injury is seen. Local conditions must be studied. Spraying is a local problem. It varies with the climate, season, weather, variety and condition of the tree. No set of rules can be made for all to follow.

Concentrated lime sulphur is made by cooking together 50 pounds of fresh unslaked lime, 100 pounds of sulphur (thoroughly and finely pulverized) and water to make 50 to 60 gallons of finished product. If properly cooked, 50 gallons would make material of a strength of 1.24 specific gravity or about 28½° Baumé while 60 gallons dilution would make material of a strength of about 1.22 specific gravity or about 26° Baumé. The best grades of commercial products usually test 1.30 specific gravity or 33.5° Baumé. The points to aim at are stability of the material in storage, that it does not crystallize out, and that a minimum of sediment results, which indicates thorough utilization of materials.

Purchasing lime sulphur. Most commercial growers purchase the lime sulphur in a prepared form. Tank cars are used by some of the leading manufacturers for transportation. The material is barreled or placed in drums at various distributing points and this is the most general system. On large plantations the work of preparing the spraying materials must be entrusted to someone. It is better to trust a manufacturing chemist who standardizes all his goods than to try to do the work with poor equipment. For the small grower the amount needed is so small that he cannot afford to take the time to make the material. The same is true of most of the materials used in spraying.

Keeping lime sulphur. Lime sulphur should be held securely in closed containers, such as a barrel or drum. If exposed to the atmosphere the composition changes to some extent and evaporation takes place. It should not be held in barrels previously used for vinegar; the acid brings about changes; nor should it be mixed with arsenicals or extra lime and then left to stand for a considerable time. It may be held in iron, concrete or wooden tanks and if uncovered the surface may be protected from change by pouring over it a thin coat of any heavy oil.

It frequently happens that some lime sulphur is carried over from one year to another. When allowed to reach a low temperature crystals of sulphur are deposited on the sides of the container, weakening the strength of the solution. The crystals can be re-dissolved by scraping off, and heating them either in water or heating the solution. The freezing point of lime sulphur decreases as the density of the liquid increases. Thus, concentrates of 1.22 or 26.5° Baumé freeze at about 14° F., while concentrates of 1.28 or 32° Baumé freeze at about 5° F. Freezing should be avoided where there is danger of bursting the containers.

Dry lime sulphur. Lime sulphur as usually made contains several compounds as follows: calcium sulphide, calcium polysulphide, calcium thiosulphate, calcium sulphate and calcium sulphite. When an excess of sulphur is used, the polysulphide is increased. The higher the content of polysulphide, the better the lime sulphur; the best types show about 90 per cent of this compound. When this compound is applied to the leaf oxygen is taken up from the air and eventually sulphur is precipitated.

Dissolving dry lime sulphur in water. When dry lime sulphur is dissolved in water a certain amount of sediment remains. This consists of sulphur and chalk. If it has been exposed to the air, there will be more insoluble material than if used fresh. But if this sediment is boiled, it will go into solution. When dissolved in cold water and boiling water, the following conditions obtain:

	In cold water	In boiling water
Insoluble	17%	0.4%
Polysulphide sulphur	42%	59.0%
Thiosulphate and other combined sulphur	8%	5.0%
Lime	25%	26.0%
Sugar	2%	2.0%

Hence it would appear to be wise to use boiling water for dissolving the material, rather than cold.

Comparative values of powder and fluid. It is frequently advertised that 100 pounds of dry lime sulphur will accomplish the same results as a barrel (600 pounds) of liquid. A barrel of standard lime sulphur contains 135 pounds of sulphur and 65 pounds of lime; or 200 pounds of soluble ingredients (mostly in the form of polysulphide), in 320 pounds of water.

In a drum of dry lime sulphur there are 65 pounds of sulphur and 26 pounds lime. Of the total 100 pounds, about 2 pounds are sugar and material insoluble in water; hence it will take 2 drums of dry to equal 1 barrel of liquid. Unless the material is boiled in solution, it may take 2½ drums to equal 1 barrel. This must be considered in the purchase of the two forms. Stated in another way, 20 pounds of dry lime sulphur will be equal to 31½ gallons of the concentrate, 33° Baumé, although if the material is boiled in solution, a little over 15 might suffice. For use against San José scale, 1:8 the equivalent of 25 gallons of concentrate in a 200-gallon tank is 140 pounds of powder; and for a foliage spray, 1:40, 28 pounds would be required for a 200-gallon tank.

Injury from use of lime sulphur. From time to time injury to foliage and fruit is reported by users of lime sulphur, just as injury results from the use of bordeaux. These injuries may vary from slight injury of foliage and russeting of fruit to practical defoliation of trees to such an extent as to cause their death. In Nova Scotia it is apparently proven that lime sulphur has caused the fruit to drop off after it has set, leading to serious crop failures. The same seems to be true in other places to a greater or less extent. One must realize that spraying mixtures are used to destroy one plant or insect in the hope that they will not injure the host. In some cases the damage has been found to be due primarily to the arsenical poison used.

The chief factors in lime sulphur-arsenical injury are:

1. The character of the arsenical. The *ortho-arsenate of lead,* $Pb_3(AsO_4)_2$ or tri-plumbic as it is termed, contains three parts of lead to two of arsenic and eight parts of oxygen, and this compound is not apt to burn foliage. It is the most expensive to make and it does not kill insects as quickly as the "standard." It differs from the "standard" in that the latter is often made up of three compounds, some ortho-arsenate of lead, some pyro-arsenate of lead, ($Pb_2As_2O_7$) which contains two parts of lead to two of arsenic and seven of oxygen, and acid arsenate, ($PbHAsO_4$), made up one part of lead and one of arsenic, with the addition of one part of hydrogen and four parts oxygen. The two latter compounds are stable in the presence of an acid, but in the presence of an alkali or in a neutral media they change to the ortho-arsenate of lead. This causes the liberation of arsenic which is believed to be the cause of the burning. The injury usually occurs only on peach foliage. The remedy is to secure the ortho-arsenate of lead for use in such cases or to add some lime to the spray mixture to combine with this arsenic to form arsenate of lime. The lead-hydrogen-arsenate of lead or "acid" lead has considerable value as a fungicide and may be used with lime as a spray for this purpose on such varieties of apples as Grimes, Jonathan and others which are not susceptible to scab or blotch.

Ortho-arsenate of lead does not carry as much arsenic per pound of material as the standard and to get the same amount of arsenic into solution 2½ pounds should be used for 2 pounds of standard. The actual minimum of arsenic oxide in the ortho-arsenate of lead is 12½ per cent on a basis of 50 per cent water free material; that is, the paste contains but 50 per cent of water, while in the standard lead the actual content of arsenic oxide should be not under 15 per cent. In the case of the standard powder arsenate of lead the actual content of arsenic oxide should be not less than 30 per cent.

"Standard" arsenate of lead is easier to make and is cheaper. It is referred to as the "acid" arsenate of lead but this does not mean that it is acid in reaction, but refers rather to the form of combination in which it occurs. Compounds in which the base, in this case lead, replaces only part of the atoms of hydrogen of an acid are always spoken of as acid salts; in these two latter compounds the chemical change in the displacement of the hydrogen atoms has not gone the full extent. Arsenate of lead is the name for three different substances, all of which are arsenates of lead and all have a different behaviour with substances with which they are placed in contact.

Lime sulphur is a mixture of at least half a dozen chemical substances and these may indirectly have an effect upon the arsenate of lead. A solvent action is apparent in the presence of soda or potash in the spray mixture; or water containing such substances will cause trouble. The soluble sulphur compounds made up with soda or potash in place of lime are apt to cause burning by their solvent action and the formation of new substances in the solution, probably accompanied with the formation of free arsenic oxide, hence the reason for adding lime to these when used as foliage sprays. The purity of the lime sulphur itself is important. If made from impure lime and other chemicals are present, burning of foliage may result. If the leaves and fruit have been injured previously by any cause whatever, punctured by hail, insects, or previous application of spraying material, the injury will be increased by burning of the cells all round the margin of the injury.

Density and abundance of spray applications. Spraying solutions must not be made too strong, nor should trees be drenched when a light mist ought to be applied. When spraying peaches with arsenate of lead, it is wise to take care not to drench the foliage. The same is true of apples. There are times when trees can be drenched with safety as before the blossom spray, but even then too strong an application will do injury. The great danger with the spray gun is that a drenching spray will be given when a mist should be applied, or the gun be held so close to the tree that the foliage is injured. The foliage may be destroyed quickly by the careless use of the spray gun.

The size of the drops that collect and the time required for the material to dry are important. Calcium polysulphide, the important ingredient in lime sulphur, decomposes most rapidly and diminishes in fungicidal efficiency most rapidly when the sprayed surface dries slowly, and if sulphides are absent lime sulphur will not prevent the germination of scab spores even if used at a strength of 1 to 10 of water. Spraying is always best when done on bright days, which are not too hot. Sulphur is destructive to the spores of apple scab when the temperature remains at 78° F. for five hours, which explains why sulphur and its compounds may be efficient in Virginia and a failure in New England or Nova Scotia where such a temperature is seldom secured. The use of a fine spray is best—just as fine as can be used to do the work properly.

Differing resistance of varieties. Some varieties, as Ben Davis and Rhode Island Greening, are much more apt to show russeting of skin than Baldwin. This must be taken into consideration in the use of the sprays.

Seasonal and local differences. What is one man's meat is another man's poison. The spray that one man can use on a variety may be absolutely unsafe for another man; it may be unsafe for the same man another season. There is nothing certain.

Excessive temperatures. Very high temperatures will scald the sides of the fruit without the application of any spraying material, but if some spraying material be applied it may aggravate the trouble. Spraying while fruit is hot is undesirable if it can possibly be avoided. Frequently it happens that spray injury occurs from still other causes, some perhaps as yet unknown.

Spray injury on foliage from lime sulphur. Foliage is more easily injured under the following conditions:

1. In regions lacking sunshine.
2. In seasons deficient in sunshine. When sunlight is lacking the foliage lacks vigor. This is seen when the growing season has been cloudy or wet.
3. When three sprayings are made instead of one or two. The more often the spray material on the leaf is wet the greater the injury.

4. When the tree is bearing a load of fruit.
5. When the tree is in sod and growing slowly.
6. When the tree is diseased in trunk or root, or lacking in vigor.

In Nova Scotia, where the amount of sunshine in the summer months may average but three to four hours a day for the season, it is fully proven that lime sulphur reduced the crop yields 20 to 50 per cent and in some cases more, depending upon the variety; that when only one spraying was given immediately after the blossoms fell, injury might be entirely absent; but if two or three were given in certain seasons practically all of the apples might be taken off. This was due to the effect of the lime sulphur on the chlorophyll—the green coloring matter in the leaves. When the spraying was made thoroughly from the under side of the foliage the injury was greatest. The lime sulphur is absorbed by the chlorophyll, apparently, and this causes either permanent or temporary derangement of the functions of the leaf. Hence it is advisable in seasons when the humidity is high and the amount of sunshine is low, or the rainfall excessive, that the spraying shall be made downward, and that not too great an amount shall be blown onto the under surface of the leaves.

It is becoming apparent that local conditions are of paramount importance; that the use of the high power spraying outfits has been an important factor in increasing lime sulphur injury; that in the earlier days when hand power outfits were in use, the injury was not so great, due to the lesser capacity of the nozzles and the smaller amount of material applied—in other words, when the work was less "efficiently" done. In dry, bright localities, where such varieties as McIntosh are grown, and but one or two sprayings are given after the blossoms fall, there may be no complaint, but with other varieties the damage may be quite serious.

Sodium polysulphide (soluble sulphur) was used as a spraying material years ago and abandoned. Recently its use has been revived. The potassium polysulphide (liver of sulphur) has been recognized as a satisfactory spray to control mildew on gooseberries, but for orchard sprays both sodium and potassium sulphides must be used with care. Even for the dormant spray, if soluble sulphur is put on in excessive amounts, that is if the tree is drenched and the spray material runs down the bark of the young trees it is apt to cause injury to the bark. These have caused a certain amount of injury to foliage when used as a foliage spray. Certain proprietory materials, compounds of sulphur, are on sale.

Calcium arsenate may be used with soluble sulphur to make a combined spray, provided at least 10 pounds of hydrated lime be used for 50 gallons of water. There was in 1919, a variation of from 1.79 per cent to 59.92 per cent of sulphur in the various compounds sold as sodium sulphur in the United States. Its value depends upon the amount of sulphur present and its form of combination.

Barium sulphur. In this material barium is used instead of calcium and it is reported as giving satisfactory results as a scale-destroying material. Some report satisfactory results from its use as a foliage spray. Certain barium sulphur compounds contain 16.54 per cent of sulphur while others contain 44 per cent sulphur, this variation not being so great as in lime sulphur mixtures sold the same year; the latter varied from 3.97 per cent to 56 per cent. Hence not all sulphur compounds have equal values. We estimate the value by the amount of sulphur present in the form of a polysulphide.

Sulphur sprays compared. The relative value and comparative cost of lime sulphur and other sulphur sprays are shown in the table below. Lime sulphur was valued at 22 cents a gallon, barium sulphur at 9 cents a pound, dry lime sulphur at 10 cents a pound, sodium sulphur (soluble sulphur) at 8 cents a pound and potassium sulphur at 12 cents a pound. Parrott of Geneva (N. Y.) station worked out the amounts of materials necessary to use to furnish equal amounts of sulphur in a satisfactory form of combination, as follows:

Dilution and Comparative Costs of Lime Sulphur Substitutes

Material	Amount required to make 50 gallons spray		Cost of 50 gallons of spray	
	Dormant	Summer	Dormant	Summer
1 Lime sulphur (Liquid 33° B.)	5½ gals.	1.1 gals.	$1.11	$0.22
2 Barium sulphur (B. T. S.)	34 lb.	6.8 lb.	3.07	0.61
3 Lime sulphur (Dry)	26 lb.	5.2 lb.	2.63	0.53
4 Sodium sulphur (Soluble sulphur)	26 lb.	5.2 lb.	2.08	0.42
5 Potassium sulphur (Liver of sulphur)	38 lb.	7.6 lb.	4.60	0.92

Self-boiled lime sulphur. When lime and sulphur are boiled, the two ingredients chemically unite to form new substances making lime sulphur. In self-boiled lime sulphur the two ingredients remain as they were; the sulphur is still sulphur but in a very finely divided form. This wash was made to control brown rot on the peach. For years brown rot, scab and curculios tormented the peach-growers, the curculio paving the way for the brown rot spores to get inside the skin of the fruit and cause the familiar brown rot which later gives place to the mass of spores. The spores of themselves cannot gain entrance to the peach; entrance must be made for them by an agent breaking the skin. Therefore, if all the skin of the peach is coated with some agent which is death to these spores or which will inhibit their growth, the brown rot is under control. Sulphur is such an agent. This material has been used as a foliage spray for apples in Delaware and New Jersey. It is made of 8 pounds of lime, 8 pounds of sulphur and 50 gallons of water.

Method of preparation. Lime is placed in a barrel and water added to cover the lime and start it slaking; as soon as slaking begins sulphur is added; it is run through a sieve to break up the lumps. Water is added from time to time to prevent the sulphur from scorching and the whole is kept well stirred. Water is gradually added to form the whole into a thick paste and then into a thin one. As soon as the lime is all slaked, sufficient water is added to prevent further cooking. Great stress is laid upon the importance of checking the cooking at the right time; otherwise if allowed to remain hot for fifteen or twenty minutes after the lime is slaked the sulphur goes into solution and produces combinations with the lime which are injurious to peach foliage.

Wettable sulphur. It is the sulphur that is precipitated from the lime sulphur that insures the protection of the foliage and fruit. Hence, the attempt to apply direct. Since sulphur does not mix well with water it is applied as dust. In certain windy sections the dust may be blown off the foliage; or when applied shortly before harvesting, as with hops, the pickers complain of irritation to the eyes when they must work among the plants. To get rid of this trouble a sulphur paste is made. Sulphur, however, when thrown into water runs into small pellets or balls, which float. To overcome this trouble a number of substances have been used, such as soap, flour paste, oleic acid, glue, dextrin, diatomaceous earth, which when mixed with sulphur tend to overcome its aversion to water. In making these preparations nothing but the finest sulphur should be used.

A common formula is: Powdered glue, 1½ ounces; hot water, 3 gallons; sublimed or powdered sulphur, 8 pounds; hydrated lime, 4 pounds and water, 50 gallons. The glue may be cooked over night in 3 gallons of cold water or be dissolved in hot water. It is added to the sulphur a little at a time. It is then strained through a very fine sieve into the tank, using the remainder of the glue water to wash it through. A stiff brush is useful for working the paste through the screen. Various proprietary materials of similar character are available. Another formula is 8 pounds sulphur, 4 pounds hydrated lime, ½ pound glue, 50 gallons of water. New Jersey dry mix is made by mixing 8 pounds superfine sulphur, 4 pounds hydrated lime, 8 ounces calcium caseinate together. This is enough for 50 gallons of water. Kayso is better than glue if arsenate of lead is to be used. Glue tends to increase the burning of arsenate of lead.

It is not advisable to apply sulphur paste or even dry sulphur to plants when the temperature exceeds 100° F. In the case of apples no injury may be apparent if the hot spell lasts but one or two days, but if it lasts longer burning may be seen. These wettable sulphurs can usually be mixed with other spraying materials.

Calcium arsenate. Calcium is a relatively cheap metal and one in common use in many of our spraying compounds. At least three combinations of calcium and arsenic may be found on the market. The burning from this compound may be due to the ease with which one compound may change to another. Powdered calcium arsenate contains 40 to 46 per cent of arsenic pent-oxide with not more than 0.75 per cent water soluble arsenic pent-oxide. In density it should be not less than 80 and not more than 100 cubic inches per pound. A pound of calcium arsenate carries more arsenic than a pound of arsenate of lead and not only does it usually sell for less per pound, but the amount used is less. It is sold in paste and dry form, the latter being generally preferred. The amounts usually advised are three-quarters of a pound of powder, or 2 pounds of paste, to 50 gallons of water or diluted spray material. It is sometimes used on apples, pears, grapes and vegetables but not on tender foliage as stone fruits, peach, plum, cherry, etc.

Do not use arsenate of lime alone on apple foliage or the foliage of any other fruit. It may be used with bordeaux mixture to which an excess of lime has been added. It may also be used with soluble sulphur, but at least 5 pounds of hydrated lime should be added to each 50 gallons if this combination be used. At the present time it is quite capricious in its behaviour, in some cases being satisfactory and in other instances burning the foliage seriously.

Magnesium arsenate as made contains 2 per cent more arsenic than lead arsenate, samples being guaranteed to contain 33 per cent arsenic oxide. The tolerance of free arsenic oxide in the government specifications is 0.75 per cent and good samples show as low as 0.25 per cent. This material shows superior powers of remaining in suspension and sticking to foliage. It is not absolutely safe to use it alone on foliage since it may cause burning. It may be used in combination with lime. It combines well with bordeaux mixture.

Paris green is not as safe a spray as arsenate of lead. It is apt to injure fruit and foliage and cannot be used with lime sulphur. It possesses a certain amount of fungicidal value and is an insecticide.

Zinc arsenite was placed on the market in the attempt to find a cheaper metal than lead with which to combine the arsenic and yet preserve the spreading qualities which lead compounds possess. Zinc has replaced lead to a large extent in the manufacture of white paints and its use as a spraying material is worthy of further trial. The arsenite of zinc is of value for potato foliage but has not made headway as a spray for fruits.

Contact sprays. The standard spray material for insects which suck their food as aphis, either the green or the rosy, is nicotine in some form, usually nicotine sulphate. The usual course of procedure is to apply three-fourths of a pint of nicotine with 10 pounds of fish-oil soap in 100 gallons of water.

Nicotine-lime solution. Parrott suggests the use of nicotine and lime for aphis on young trees and those not bearing fruit. This preparation consists of 60 to 80 pounds of lump lime which is slaked and screened and then made up to 100 gallons with water. To this he adds 2 pounds of copper sulphate and three-fourths of a pint of nicotine. This has proven very efficient against aphis. He makes a very important suggestion—that the strainer of the suction hose be taken out of the tank until one is ready to apply the material; if one fills the tank at the yard and has to drive a quarter of a mile, do not leave the strainer in the tank to become clogged and coated with the lime but insert it into the material after it is thoroughly agitated.

Kerosene emulsion is used against plant lice and for soft-bodied insects. It may be prepared by the following formula: Soap, one-half pound; water, 1 gallon; and kerosene, 2 gallons. Dissolve the soap in hot water and while still hot add the kerosene. Pump the liquid back into itself for five or ten minutes or until it becomes creamy. This may be done by running it through a pump, if one is handy. If properly made the oil will not separate on cooling. For use on dormant trees dilute with 5 to 7 parts of water. For use against plant lice on foliage, dilute with 10 to 15 parts of water. The strength of the oil emulsion is usually indicated by the percentage of oil in the diluted liquid. For instance, for 10 per cent emulsion add 17 gallons of water to 3 gallons of stock emulsion; for 15 per cent emulsion, add 10⅓ gallons of water to 3 gallons of stock emulsion; for 20 per cent emulsion, add 7 gallons of water and for a 25 per cent emulsion, add 5 gallons of water. Crude oil emulsion may be made by substituting crude oil for kerosene.

Distillate emulsion is sometimes used in California, and is made as follows: Distillate, 28° Baumé, 20 gallons; whale oil soap, 30 pounds; and water, 12 gallons. Dissolve the whale oil soap in water heated to the boiling point. Add the distillate and agitate thoroughly while the solution is hot. Use 1 gallon of this stock emulsion to 20 gallons of water.

Carbolic acid emulsion is sometimes used in California for plant lice, mealy bugs and soft brown scale. It is made of whale oil soap, 40 pounds; crude carbolic acid, 5 gallons; and water, 40 gallons. Dissolve the soap in hot water, add the carbolic acid and heat to the boiling point for twenty minutes. One gallon of stock emusion is diluted with 20 gallons of water when used.

Nicotine oleate is suggested by Moore of Minnesota. It is made by thoroughly mixing 2½ parts of a 40 per cent free nicotine solution like nicofume* with 1¾ parts of commercial oleic acid—"red oil." Use one-third of a pint to 50 gallons of soft or rain water. Nicotine oleate emulsion is made by mixing thoroughly 10 parts of cotton-seed oil or kerosene, 1¾ parts of red oil, and 2½ parts of 40 per cent free nicotine solution. After mixing well add 10 parts of soft water and shake well. For mealy bug, white fly and soft scales, dilute with soft water to make 500 parts.

Miscible oils. There are now on the market several miscible or soluble oils intended primarily for use on San José scale. These are usually diluted 1 part to 15 parts of water. It is generally advised to delay application with all oil sprays until the buds are ready to start, but do not let the buds open. They should not be applied on a day when the temperature will fall below 40° F., before the spray is dry. Nor should they be used when it is raining.

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* In Blackleaf 40, the nicotine is in the form of nicotine sulphate, and is relatively stable, while in nicofume it is in a form which readily evaporates

Home made miscible oils can be cheaply made. To make 200 gallons of 2 per cent oil spray, suitable for a delayed dormant application for San José scale and aphis, use Formula 1: 4 gallons engine oil, 2 gallons water, ½ pound copper sulphate, ½ pound burned lime. Dissolve the copper sulphate and slake the lime as for bordeaux mixture, a pound to a gallon of water. Add the 2 quarts of copper sulphate solution to the 4 gallons of oil and then add the milk of lime and immediately pump the mixture through the sprayer twice to emulsify. Dilute and apply. Formula 2: A stock solution may be made up with Kayso or Saponin (soap bark extract), 8 ounces stirred in 2 gallons of water, add to 4 gallons of oil and emulsify. Stir well before using. The oils used are paraffin Diamond, Red Engine, Nabob, 180 neutral or other cheap engine oils. A 20 per cent oil spray has been used without injury but a 2 per cent showed 96 to 99 per cent kill of scale and aphis.

Spreaders. In the development of spraying, attention is given to materials to ensure better distribution. Several of these "spreaders" are on trial as—miscible oil emulsion, crude oil, casenite, kayso, soap bark, etc. With a satisfactory spreader it may be possible to reduce the strength of the solution and secure as good or better results. It is generally conceded that with our improved machines and methods we are probably using too strong solutions. The progressive orchardist will keep in touch with the situation, allowing the experiment stations to work out the details so that any changes instituted may be based on actual knowledge.

Kaolin. The use of a fine clay in our spraying materials is a possibility. It is a repellant and a good carrier. It is on trial experimentally. It is promising for use in dusting.

Dusting materials. The materials for dusting may consist of 85 per cent sulphur and 15 per cent arsenate of lead, or 90 per cent sulphur and 10 per cent arsenate of lead. These are used to control chewing insects and fungi. For peaches this material is sometimes diluted to contain 50 per cent sulphur, 40 per cent filler (usually gypsum finely ground or hydrated lime) and 10 per cent arsenate of lead. Powdered bordeaux mixture and other copper-lime dusts are on trial again. Sander's dust, a mixture of finely pulverized hydrated copper sulphate and lime (which have not been chemically united), has given very good results in some places. Where aphis are in evidence a contact insecticide such as finely ground tobacco, showing a high nicotine content, may be applied direct; or nicotine sulphate in a carrier of lime may be used. A more recent insecticide is hydrated lime saturated with nicotine sulphate. Recent investigations indicate that the fumes of the nicotine destroy the aphis. If the nicotine is held in a material that will promptly liberate it as hydrated lime or sulphur, the aphis are fumigated. The monohydrate copper sulphate used in preparing certain copper sulphate lime dusts retards the escape of nicotine, hence, these should not be used together. Calcium cyanide is proving useful as a dust and soil fumigant.

Applying the dust. The fungicidal value of sulphur is directly proportional to its fineness. The finer the materials the better they stick. The materials should pass through a mesh screen of two hundred meshes to the inch in each direction; this is twice as fine as flour. One pound of dust will cover about as much as 3 to 4 gallons of liquid. One might allow 2½ pounds for apple trees which take 8 to 10 gallons of spray material. In the author's judgment the material is best applied early in the morning before there is any wind or at night as the dew is falling, and when there is no wind. The fine particles lodge among the small hairs which cover the foliage and fruit. The aim in dusting should be to coat the trees from both sides if necessary, just as would be done in applying the liquid. If the trees are large this can be done by driving up one side of the row and coming back on the other. The outlet pipe should be swung in passing so that not only the lower branches, but also the upper parts of the tree are coated. The speed should be slow enough to permit this work. If the wind is blowing, better not dust; but if done, the dusting should be made with the wind and repeated from the other direction on another occasion. Still days are best. Usually sufficient material for the half-day can be put on the wagon so there is no delay in the work. As high as forty acres can be dusted in a day by one crew, using one of the largest machines. Dusting one side of the trees only, and with trees 16 to 20 feet tall, 80 to the acre, one can dust five acres an hour.

Dusting conclusions. Dusting is more economical on large trees than on small ones. Some decided advantages of the duster are: (1) It is more rapid; the fruitgrower can do the work on time and maintain practically perfect control; (2) the outfit is light; it can be used on soft and wet ground; (3) the work is cleaner than spraying and (4) the fruit, for instance cherries, plums and peaches may be dusted even shortly before harvesting without danger of staining the fruit. This may insure a crop which can be shipped when those not so treated will be a failure.

The disadvantages are: In wet weather the dust is perhaps more easily washed off than the liquid and the work may need repetition, increasing the cost somewhat.

The beginner should use a cheap material, as lime, when he first operates the machine; in other words, learn how to handle it with something less costly than sulphur. I know a man who used $6 worth of dusting material in the first six minutes the duster ran and it all disappeared while he was learning how to shut off the flow. A dollar a minute! He put the machine back in the barn saying it was too expensive a toy for him to play with, but he is using it just the same and would not be without it. In the author's experience, there is a place for the duster. It has given excellent results under most trying conditions, at a cost no greater than for spraying and with a fraction of the work. In the wet season of 1922 we carried McIntosh apples through, practically free from scab, and packed 99 per cent fancy fruit. We dusted 12 times, practically every week, using copper sulphate and lime dust (Sanders dust), and in some of the dustings arsenate of lead in addition. The program consisted of two dustings of copper sulphate and lime with arsenate of lead prior to bloom and a dusting with sulphur as the blossoms were opening to control scab, and two applications of 90 per cent sulphur and 10 per cent arsenate of lead, one after bloom, another about eight days later. The other applications were with copper-sulphate-lime, some with and some without arsenate of lead and one of sulphur when short of material. Trees 18 to 20 feet tall were dusted from one side one week and the other side the next; this was ample. Some weeks it took six, others seven hours to do 30 acres of orchard. Red bugs were perfectly controlled in 1921 by dusting with finely powdered tobacco, and aphis in 1922 by the same material. There is no use dusting if the wind is blowing. We prefer to have the whole orchard in a state of fog for a couple of hours.

Apple-Spraying Program

The apple-spraying program will depend somewhat upon the location, on the insects and diseases which are prevalent, and on the climatic conditions. Generally speaking, the following sprays are given:

Dormant spraying is usually given for San José scale, blister-mite and certain fungus diseases. It is often applied just as the buds start or when the leaves are about one-fourth inch long. Where there is blister-mite, it must be given as the buds are breaking, and for this pest and San José scale, lime sulphur, 1 gallon to 8 is usually used, or an oil spray such as scalecide or other soluble oil. If aphis or red bugs are hatching, nicotine, as in the second spraying, may be added to the lime sulphur.

Delayed dormant spraying. Where the blister-mite is not prevalent, but apple scab, bud moth, brown-tail moth, canker worms or tent caterpillars are prevalent this spraying may be delayed until the leaves are one-fourth inch to one-half inch in size, or even until the blossom buds are spread. Arsenate of lead is mixed with it and the tree drenched thoroughly. When lime sulphur and arsenate of lead are used together, add 10 pounds of slaked lime to each 100 gallons of the mixture. In many places, lime sulphur may be used at this strength, 1:8, until the blossom buds show pink, without serious detriment. This spraying may be timed to control aphis.

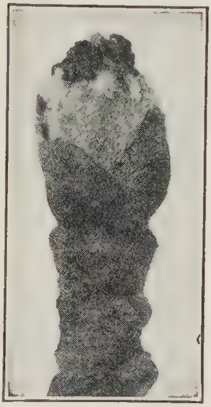

FIG. 53. The delayed dormant spray may be made while the Apple-bud Aphis are on the apple bud. This is the time to spray, if they have not been killed while in the egg *U. S. D. A.*

Scab and aphis spray. Apply when the blossom buds show pink. (In Nova Scotia, where the green apple bug is present, this spraying is delayed until the blossoms are almost open.) This spraying is given to control apple scab, bud moth, canker worm, fruit worm, green apple bug, brown-tail moth in the northern apple regions, and further south, cedar rust. In the North, a bordeaux spray is preferred with arsenate of lime or arsenate of lead added to it; or lime sulphur solution, 1 gallon to 40 gallons of water may be used instead of the bordeaux mixture. If aphis or red bugs are prevalent, one-half to three-fourths of a pint of 40 per cent nicotine sulphate to 50 gallons is added. The amount of arsenate of lead used will vary from 1 to 1½ pounds of powder, or 2 to 3 pounds of paste. Add 10 pounds of hydrated lime per 100 gallons if arsenate of lead is mixed with lime sulphur. In special cases one may need to make a special spray. If there is delay in applying, it is best to spray the trees while in bloom rather than omit it, in which event the arsenicals are omitted.

First Codling moth spray is given as soon as the blossoms have fallen and before the calyx is closed. In practically all parts of the country, bordeaux mixture cannot be used at this time without injury. In some places, the advice is to use lime sulphur, 1 to 50, with 2 to 3 pounds of paste arsenate of lead added. In others arsenate of lead is used alone. Use plenty of material and be sure to fill the calyx cups with poison. This spraying is largely to control the codling moth, curculio, canker worms, fruit worms, tussock moth and apple scab in districts where serious. Recently, the use of sulphur paste, wettable sulphur, atomic sulphur or self-boiled lime sulphur, sulphocide or weak solutions of sodium polysulphide are being tried for this and the later summer foliage sprays. In Nova Scotia, 1 quart of sulphocide, or 1 pound of soluble sulphur is used, with one-half pound of arsenate of lime and 5 pounds of hydrated lime to 40 gallons of water. This is 50 gallons American standard. Nicotine may be used in addition, if aphis or red bugs are present.

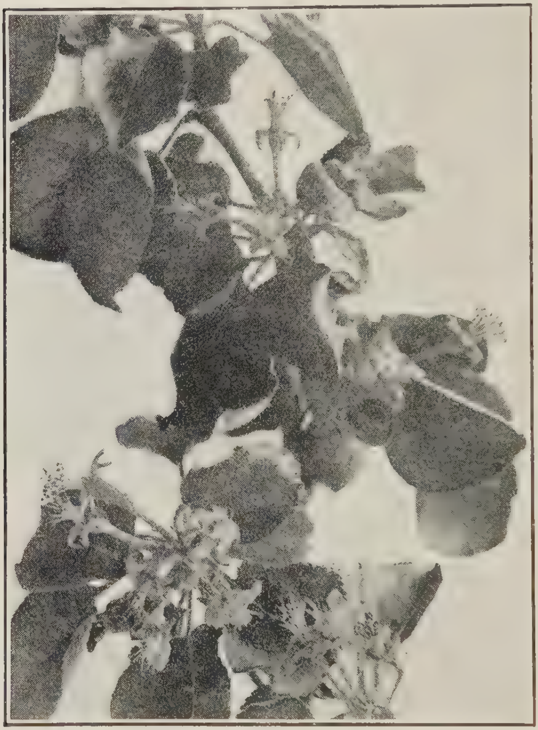

Fig. 54. Apple bloom just ready for the first codling moth spray. The calyx is wide open. In a few days, sometimes three or four, it will close and then no poison can be placed inside it

Second codling moth spray. About ten days to two weeks after the first spray, a second codling moth spray may be given. Where there is a tendency to bitter rot, and in the northern apple-growing regions where scab is prevalent, bordeaux mixture is used. A weak bordeaux spray is used in Nova Scotia, one in which there is an excess of lime 2:10:40. The bordeaux is mixed with 1 pound arsenate of lime, (40 gallons Canadian equals 50 gallons American measure). The excess of lime makes safe the use of arsenate of lime. In the Central Western states a bordeaux mixture of 3:4:50 with arsenate of lead may be used if bitter rot is feared.

Third codling moth spray. Sometimes, in two to three weeks after the second spraying another may be necessary to control the second brood of codling moths and late scab infections, also such fungi as blotch and bitter rot. It will depend somewhat upon the variety grown and the conditions whether bordeaux, wettable sulphur or a weak lime sulphur spray or some other will be used. There is a marked tendency to return to the use of copper sprays where they can be used with safety. There is also a tendency to increase the number of sprayings, realizing that frequently it is inadvisable to try to do too much at one time.

Where special problems come up, special sprayings must be arranged. Where three broods of codling moths occur one may need to spray in late August or September. The same is true in regard to late scab and bitter rot infections. The rapidity with which an orchard may be dusted will modify our practice and make combinations somewhat different from those now in mind. Late codling moth infestations may be held in check by dusting, using 45 pounds hydrated lime, 40 pounds sulphur and 15 pounds arsenate of lead; or 50 pounds of lime, 40 pounds sulphur and 10 pounds of arsenate of lead. Scab control may be secured by dusting with a mixture of finely pulverized copper sulphate and hydrated lime.

Number of times to spray. The number of times we must spray varies with conditions. Usually we do not know how many sprayings we should make, therefore the only safe thing to do is: (a) to spray the maximum requisite number of times; (b) to have enough sprayers on hand to do the work on time in the worst season. The climatic conditions and diseases modify the practice. Apple blotch, cedar rust and bitter rot have not been controlled or held in check by lime sulphur sprays. Hence, there is a decided tendency to return to bordeaux mixture where these diseases are important.

In Ohio, control of apple blotch is reported by the use of 3:5:50 bordeaux applied two weeks after the petals fall and again two weeks later, with another spray six weeks after bloom and another ten weeks after, in which arsenate of lead is used to control the second brood of codling moth. In New Jersey and especially in Central and Southern New Jersey and in Delaware the change is being made to sulphur paste as atomic sulphur, wettable sulphur and self-boiled lime sulphur 8:8:50 for the summer spraying of apples. This is to get away from the russeting of the fruit and the failure to get satisfactory control from lime sulphur.

Spraying apple trees in bloom. The general advice is not to spray when apple trees are in bloom. In some states it is illegal to do so. With many varieties of apples it is difficult to control a disease as scab on McIntosh, Rhode Island Greening and other varieties in western New York, on most varieties in Nova Scotia, and on certain varieties in the Middle West where this disease is prevalent. Where it is known that the "cluster bud" spraying is vital the spraying of the stem of the apple should be done as soon as it has separated in its cluster and the buds are ready to break. Unfortunately, it frequently happens that rain or other conditions prohibit the work being done. This is especially true where the acreage is large and in seasons when the varieties all come in bloom together.

Spraying while the trees are in bloom. Experiments conducted for three years in Illinois show that spraying while in bloom in the case of ten varieties of apples with the common fungicides applied at pressures not exceeding 300 pounds had no injurious effect upon the bloom or the number of apples set. Sprayings while in full bloom with bordeaux mixture 4:4:50, lime sulphur 1 to 20 and scalecide 1 to 20 caused no apparent injury. The spraying of such varieties as McIntosh, Delicious, Rome, Red June, Early Harvest and other varieties while in bloom may be advisable in certain locations. The results secured at the Indiana station show that spraying with arsenicals when trees are in full bloom caused a heavy mortality among the bees, and since bees are valuable as pollenizing agents these poisons should be applied when the bees are less active among the trees. It may be pointed out that the Illinois experiments were with fungicides and there is no conflict in these statements. Melander states that a quart of miscible oil to the tank (200 gallons) of spraying material will keep the bees away.

Amount of spray to use. When making the dormant spray the writer has used from 5 to 7 gallons on an apple tree which would bear ten barrels of fruit. To give a thorough spraying when the tree was in foliage required 15 to 17 gallons. Full-sized peach trees when planted 20 feet apart will take 2 gallons each for the dormant spray, and 3 to 4 gallons for a later spray, unless at a time when a mere mist is required, in which case one gallon through a very fine nozzle is ample.

Labor cost of spraying. In Wenatchee, Washington, with a crew of three men and two horses, it was possible to spray

3.64 acres in ten hours, applying 5.9 gallons per tree, or 478 gallons per acre in the fourth spraying. In the first lead arsenate spray 539 gallons were used. The figures for all four sprays are given below:

TIME REQUIRED AND AMOUNT PER TREE

	Dormant lime sulphur	First lead arsenate	Second lead arsenate	Third lead arsenate
Acres per 10 hours	3.51	3.35	3.59	3.64
Gallons per tree	6.1	6.7	6.2	5.9

The labor and material costs are shown in the table below. Men were paid 25 cents an hour; man, team and sprayer, $1.50 an hour, and man and team $5.50 a day. Lime sulphur cost about 18 cents a gallon and arsenate of lead 10 cents a pound. Standard solutions were used.

LABOR AND MATERIAL COSTS PER ACRE FOR SPRAYING—WENATCHEE, WASH. 1915 AND NEW YORK 1910-15

	Number	Per acre			Gallons			Material cost
Kind of spray Washington (81 trees to the acre.)	growers	Man hours	Horse hours	Labor cost	per day	per acre	per tree	per acre
Lime sulphur 1:10	69	8.79	5.86	$3.08	1,734	494	6.1	$8.89
First lead arsenate 2:50 .	76	8.95	5.97	3.13	1,804	539	6.7	2.15
Second lead-arsenate . .	55	8.34	5.56	2.93	1,812	505	6.2	2.02
Third lead-arsenate . . .	44	8.24	5.49	2.88	1,740	478	5.9	1.91
Fourth lead-arsenate . .	3	9.66	6.44	3.38	1,743	561	6.9	2.24
In New York (35 trees to the acre.)								
Dormant spray	94	7.06	4.71	$2.12	1,139	240.78	6.88	$3.48
Pink spray	34	7.78	5.19	2.33	1,125	248.88	7.32	1.87
Calyx spray	95	7.66	5.11	2.30	1,136	252.38	7.21	2.01
Fourth spray	27	8.22	5.48	2.47	1,189	268.72	7.46	1.91
Fifth spray	37	5.98	3.99	1.79	1,000	185.36	5.62	1.48
Sixth spray	26	8.40	5.60	2.52	1,247	299.80	8.33	2.35

Three men to a crew is more economical than two men.

In Hood River, the man hours required to spray an acre varied from 4.29 to 5.06 hours, with an average of 4.55. Horse hours varied from 3.38 to 5.71, with an average of 3.59 hours per spraying per acre.

Cost of spraying an orchard. In New York large trees, forty-five to sixty years of age, were sprayed by labor at 17.9 cents an hour and horse labor at 15.3 cents an hour per horse. Both of these factors were low on account of the fact that the orchard was run as part of a general farm. Lime sulphur was purchased at a cost of 16 cents a gallon in 1911 and 14 cents in 1912, and lead arsenate at 8 cents a pound. The orchard is in Western New York and is known as the Wellman orchard. It contains 14.7 acres and 527 trees. The crop of 1911 was 937 barrels and in 1912, 2,104. Naturally, the cost per barrel was much less in 1912. A summary of costs is shown in the table below.

COST OF SPRAYING WELLMAN ORCHARD, WESTERN NEW YORK

Year and operation showing total amounts spraying material used	Hours per acre		Cost per acre			Cost of both material and labor	
	Man	Horse	Labor	Material	Total	Per tree	Per barrel
1911							
First spraying . . 140 gals. Lime sulphur diluted 1-10, 32 lbs. Arsenate of lead, 3 pts. Tobacco extract on part.	3.34	2.61	$0.998	$1.686	$2.684	$0.075	$0.042
Second spraying . . 43 gals. lime sulphur, 102 lbs. lead arsenate.	3.05	2.03	.859	1.020	1.879	.053	.030
*Third spraying . . 32 gals. lime sulphur, 77 lbs. lead arsenate.	3.29	3.26	1.088	.765	1.853	.053	.029
*Fourth spraying . 15 gals. lime sulphur, 36 lbs. lead arsenate.	1.63	1.63	.541	.358	.899	.025	.015
Total for season .	11.31	9.53	3.486	3.829	7.315	.206	.116
*Trees with fruit on only.							
1912							
First spraying . . 155 gals. lime sulphur.	3.76	2.44	1.048	.929	1.977	.055	.013
Second spraying . . 44 gals. lime sulphur, 105 lbs. lead arsenate.	3.09	2.03	.864	.988	1.852	.052	.013
Third spraying . . 52.5 gals. lime sulphur, 126 lbs. lead arsenate.	5.43	3.66	1.532	1.182	2.714	.076	.019
Fourth spraying . . 35 gals. lime sulphur, 146.75 lbs. lead arsenate.	4.59	4.75	1.550	1.129	2.676	.074	.019
	16.87	12.88	4.994	4.228	9.219	.257	.064

More spraying costs. In the table following is given a summary of total spraying costs in New York for the years 1910 to 1915. These years are used for the reason they are pre-war costs.

SUMMARY OF TOTAL SPRAYING COSTS IN NEW YORK (1910-15)

	Wayne	Ontario	Monroe	Orleans	Niagara	All counties
Labor—						
Man hours	18.28	18.71	20.39	23.02	21.98	20.50
Horse hours	14.97	15.32	18.92	20.62	19.77	17.96
Material—						
Gallons per acre	610	876	839	1005	997	863
Gallons per tree	17.4	26.8	23.3	29.5	26.9	24.6
Cost per acre—						
Labor	$5.90	$6.04	$6.92	$7.70	$7.36	$6.79
Material	5.94	8.28	8.51	10.70	9.83	8.66
Total	11.84	14.32	15.43	18.40	17.19	15.45
Cost per tree—						
Labor	$.1686	$.1888	$.1922	$.2265	$.1989	$.1940
Material	1697	.2588	.2364	.3147	.2657	.2474
	.3383	.4476	.4286	.5412	.4646	4414

What the spray gun did. When two men and a two-horse team were equipped with a spray gun a saving was effected of one man. The material went 40 per cent further. The data for 1919, for spraying with a crew of two men and two horses with the use of a spray gun, in New York, are as follows:

LABOR AND MATERIALS—COST PER ACRE (35 TREES)

	Per cent of growers making spray with gun	Acres in 10 hours		Gallons		Hours per acre		Cost per acre		
		2 Nozzles and 3 men	Gun	Per acre	Per tree	Man	Horse	Labor	Material	Total
Delayed dormant	71	4.28	5.7	176	5	3.8	3.8	$1.90	$4.80	$6.70
Pink Spray	69	4.03	5.5	189	6	3.9	3.9	1.95	2.80	4.75
Calyx spray	100	4.13	5.3	192	6	4	4	2.00	2.81	4.81
Two-week spray	72	3.88	5.8	185	6	3.6	3.6	1.80	2.63	4.43
August 1 spray	33	4.66	5.2	171	5	3.9	3.9	1.95	2.72	4.67

CHAPTER XX

TREE SURGERY

The ordinary task of pruning is for a certain purpose—as to shape the tree; to restrict its size; to let in more light, and to thin the fruit. But frequently pruning is necessary to eliminate disease, as for instance, fire blight in apples and pears. The question naturally arises, What should be done with the wounds?

Treatment of wounds. With deciduous fruits, when the cut surface is under 1½ inches in diameter, a wound almost invariably is left alone; when larger, the wounded area is painted with white lead and oil or coal tar or bordeaux paste, or is covered with other substance. In New York, careful tests of different wound dressings showed that in many cases when these were smeared over the cut surfaces they injured the cambium layer of the cut surface and did more harm than good. The wounds healed better when not treated. If, however, one feels something should be done, paint the wood with white lead and oil, but not the bark of the cut surface. In other regions and with other fruits the results may be different. Writers on citrus and other semi-tropical fruits contend that large wounds should be kept covered to prevent the entrance of spores of destructive fungi into the cracks and crevices, and to protect the surface from water.

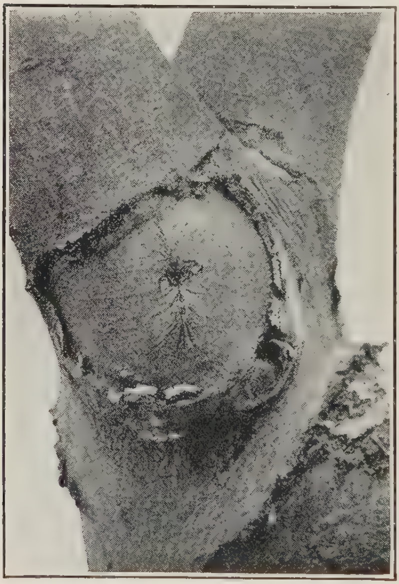

FIG. 55. Wound healed. The cut was properly made
Courtesy Utah Agr. Exp. Sta.

Wound paints. The bordeaux paste for wounds is made by dissolving 1 pound of copper sulphate in 3 quarts of water, and

2 pounds of quick lime in 3 quarts of water. The two mixtures are then brought together to make the paste. This is useful for wounds of trunks due to disease.

Asphalt paint. Heat asphaltum until fluid; then take to a safe distance from the fire and dilute with benzine or gasoline; when cold this mixture will have the consistency of paint.

Grafting wax. Any ordinary grafting wax may be used to cover wounds. For wounds made in the removal of fire blight, there is nothing better than covering with grafting wax after the wounds have been disinfected with corrosive sublimate, bordeaux paste or mercuric cyanide. Grafting wax may be used in a melted or hard condition. Melted wax is applied while hot, with a brush. Hard wax is applied cold by hand. Sometimes it is advisable to paint a cut surface to exclude air. While either hard or melted wax may be used the melted wax may be more easily worked into the crevices, especially on a cold day.

To make melted wax, take: crushed resin, 5 pounds; beeswax, 1 pound; powdered wood charcoal ½ pound and raw linseed oil, ¼ pint. Melt the resin and the beeswax in a kettle over a fire; add the charcoal and stir briskly to prevent lumping. Add the linseed oil and mix thoroughly. Apply hot, with a brush.

Another formula is: crushed resin, 6 pounds; beeswax, 1 pound and linseed oil, ½ pint. The wax is usually heated in a water-jacketed pot. This is kept hot by the use of a small kerosene lamp, which burns in the base. In this way the wax is kept hot in the orchard.

To make hard wax, take: crushed resin, 4 pounds; beeswax, 2 pounds; and tallow, rendered, not salted, 1 pound. A half pint of raw linseed oil may be substituted for the tallow. Melt in a kettle and bring to a boil; pour into cold water and pull well with greased hands as though it were molasses candy, until it has a fine grain and a light amber color. It may be softened in the hands when needed for use. When applied, the hands are kept greased or oiled with linseed oil so that the wax will not stick to them.

It is of importance that the person applying the wax shall not cut or set the scions if topworking. If the oil or grease gets on the cut surfaces which are to unite, no union will take place.

Waxed tape and waxed thread. Thread, tape or cotton cloth strips may be dipped in hot wax and allowed to drain. Such will be of value for winding around grafts or cut surfaces.

Treatment of split trees. Trees which have been improperly headed are apt to split. If such misfortune does happen, the tree may still be saved if it is worth the expense. Drawing the limbs back into shape with a block and tackle enables one to

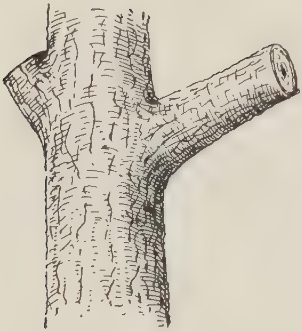

FIG. 56. Two wrong ways of leaving a stub when pruning

brace the limbs together. Auger holes are made through the limbs, and plate washers and large iron bolts used to fasten the limbs together as they were before the splitting. The bolt holes and the washers may be given a coat of bordeaux paste to disinfect them. This is especially important with citrus fruit and other trees located in tropical and semi-tropical climates. The split surfaces of the tree should also be coated with bordeaux paste before beginning operations. When all is in place, any cracks should be filled with the bordeaux paste and the bolt heads, washers and cracks given a coat of asphaltum paint.

Treatment of cavities. Due to neglect, large and valuable trees often show cavities in the branches or trunk. The remedy is to clean out the cavity and fill with cement. All wood which is not absolutely sound should be removed. The surface is sometimes charred by means of a torch or treated with creosote, and a coat of asphaltum paint is applied. Nails are sometimes driven into the surface to aid in bonding the cement put into the cavity of the tree. The right mixture is one of cement to three of sand. The surface is left so that the bark will normally grow over the filling; when smoothed off and dry, it is coated with waterproofing. The wound should be inspected annually and perhaps repainted until covered by bark.

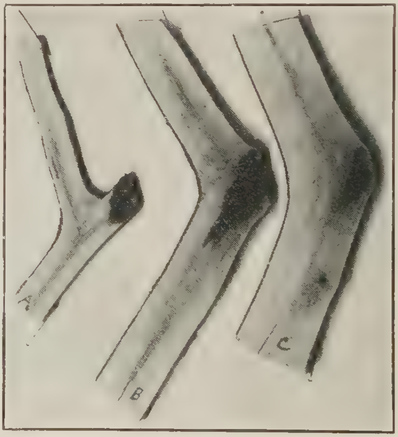

FIG. 57. How long a stub shall we leave?

A is far too long

B is longer than it should be because the bark cannot cover it over before decay sets in

C is all right *Utah Agr. Exp. Sta.*

Topworking trees. There may be conditions under which it is desirable to topwork trees.

1. When a variety has a very poor trunk, or one subject to collar-rot or winter injury as seen in the case of Twenty Ounce, Tompkins King, Grimes. For stocks it is sometimes advised to use Tolman Sweet in New York, and Paragon in Southern Pennsylvania. Some suggest Malinda or Hibernal for the North Central states and Delicious for the Central states. Spy has not proven to be as congenial as is needed in New York. Ben Davis has many defects in other regions as well as in New York, although the tree itself has a good root system. Williams Red, Melon and other weak-growing varieties are sometimes recommended as doing better if topworked. There may be places where this is true, but if it is necessary to coddle a variety it should not be considered a commercial variety. If it is desirable to grow it for home use or in a small way, that is another matter.

2. When varieties are untrue to name there is nothing to do but to pull the trees out or topwork them. In many places it would be just as satisfactory from a commercial standpoint to pull the trees out and start over again as it is to topwork. Circumstances, however, alter cases, and if the owner does the work and looks after the trees he may succeed where an employee would fail.

How to topwork. If a number of trees are to be topworked the best time is in the spring as soon as the trees are set. Take a five-eighths-inch or eleven-sixteenths-inch two-year-old tree, saw off the top at the height desired, say 18 inches, and insert a cleft graft; no time is lost. A cleft graft may be used with such trees, but on a half-inch tree a whip-graft is better. The points to watch in cleft grafting are: (a) That the cambium layer of the scion must be in contact with that of the stock. (b) The scion must be carefully

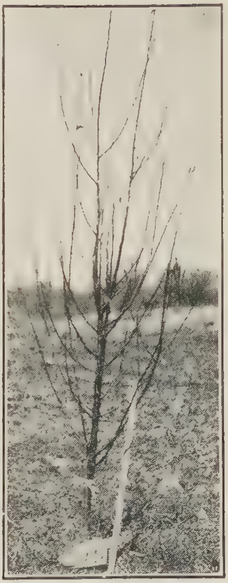

FIG. 58. Topworking. The most satisfactory topworking we have done is shown above. Two-year-old trees were planted in spring, the tops cut off at 18 inches from the ground and a cleft graft inserted at the lower white tape. The upper white tape shows nearly three feet of growth made the first season and the tree shows two seasons growth. The stick is 3 feet. Tree grown by author and is one of 10,000 topworked in two seasons at Geneseo, N. Y.

cut and the bark must not be separated from the wood. (c) If the stock is over 1¼ inch in width, insert a wedge in the cleft to take a little of the pressure off the scions; the pressure may be so great that it may crush the scions. (d) See that scions are cut in ample time, properly stored and have not been hurt the previous winter. (e) Scions are to be of the previous year's growth, not two years old. (f) Two scions may be put into a limb 1 inch or more in width. They will aid in covering the wound but care should be taken to remove one of them within a year as a double trunk tree is undesirable.

Sawing off the top. Use a fine saw and see that it is sharp to make a clean cut. The bark must not be frayed or separated from the wood. If the wood is straight grained make the cleft with the grafting iron; if not, saw it out at least part way. Drive the wedge of the chisel into the cleft; insert the scion, pushing it into place, and give the chisel a tap on the underside to drive it out. This allows the stock to grip the scion and hold it firm.

Carrying the scions. The scions should be tied firmly in a bundle and rolled in a wet sack and be so tied as not to unroll. The cut end of the scions is left exposed so that a scion can be withdrawn as needed. Frequently the grafter will cut up the graft stick, dropping the two or three scions made into his pocket. The weak wood at the tip of the scion wood is usually discarded, two or three bud scions of strong wood being used.

Waxing. The waxing should be done carefully by a man who does nothing else, and this should be done as soon as possible after the scion is set. First, a thin layer of wax is placed around the stock and pushed into place firmly, then a cap is put over the top of the cut surface and this is pushed home and tight around the scion to exclude all air or chance for water to enter. Then usually, a litle bit of wax is put on top of the scion to prevent evaporation of water from the cut surface. If desired, melted paraffin, preferably parawax, may be used. It is applied warm with a brush.

Grafting in the limbs. If desired, large limbs may be cleft-grafted and smaller ones whip-grafted, or what is often easier they may be budded—two buds put in; if one fails, one is left. If bud moths take a bud the following spring there is still the chance to graft.

Mice and rabbit injury. Mice, rabbits and gophers frequently girdle trees. Young woodchucks will sometimes do considerable damage to them with their claws. The best way to prevent these injuries is in the use of wire guards of about one-fourth inch mesh. A strong wire guard, well galvanized, will last fifteen or more years. For young trees, 18 by 13 inches may be used. The guards may be put on with the 18-inch width upright, for the first five years, and thereafter be reversed. Strong-growing trees will be over 18 inches in circumference at ten years old, and a wider piece of netting will be needed. Usually the cloth is fastened in two or three places with a bit of wire. Care must be taken that mice do not get under or inside of the guard when snow is deep.

Wooden guards are not so desirable. They shut out light. The bark of the tree, especially while young, needs light.

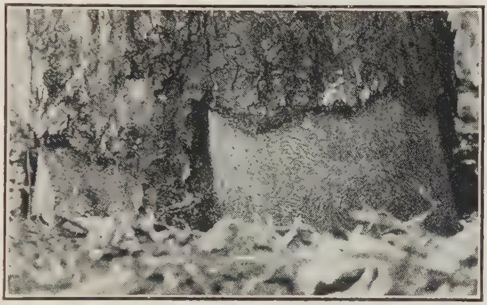

Fig. 59. Beware of mice. They may destroy all the bark at the ground level and cause the death of the tree

Penna. Agr. Exp. Sta.

Tar paper is sometimes used as a temporary expedient. It should never be left on all summer, but should be removed in early spring. The tar paper may cause death of the bark. Ordinary building paper or newspaper wound around the tree may give temporary protection and is often advised for protecting young trees when the whole tree needs protection, as in the case of young lemons and other semi-tropical trees.

Bridge grafting. Girdled trees may be saved by bridge grafting. Apples, pears, sweet and sour cherries, quinces and plums can all be saved by bridge grafting and it is worthy of trial on the peach. If carefully done, the tree may recover and be apparently as vigorous as if it had not been girdled. The important points to remember are: (a) The cambium layer of the scion and the bark of the tree must be in contact both at the top and the bottom so that the sap flow may proceed uninterruptedly. (b) Whether the grafts be sprung into position or laid in position and tacked, does not matter. (c) Insert a graft for every inch of circumference, or space them about 1 inch apart. (d) Wax the grafts as soon as possible after placing. (e) Do the work as early in the spring as possible after the sap has started to move. (f) Young trees that are apt to be swayed by winds should be staked; otherwise the grafts may be thrown out of position. (g) Frequently, covering the injured surface with grafting wax as soon as possible may save some of the cambium layer, and will check drying out of the wood.

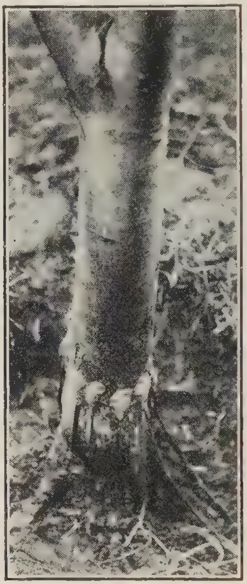

Fig. 60. Bridge Grafting. At one point the roots were gone and it was necessary to plant two small seedlings and insert the top of same into the good bark. Sometimes bridge grafts five feet long have been used
Penna Agr. Exp. Sta.

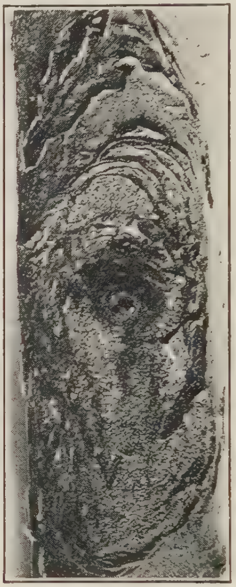

Fig. 61. New York Apple Canker as it appears the first year or two. On its surface are seen the numerous pustules which contain the spores. Note the concentric rings, made as the disease progresses.
Professor Whetzel.

Bridge grafting when the root is gone. A tree whose root is dead or dying may be saved in the following manner: Secure two or three small seedling apple trees. Clean away all diseased roots, remove all dead bark and decayed wood, apply coal tar to the surface of the sound wood and plant the seedlings close to the trunk of the old tree, inserting their tops into the live bark of the trunk. As soon as they unite, they will function as the root of the tree formerly did. A valuable tree may be saved in this way, even when badly injured.

Cankers. The treatment of cankers is usually surgical. Frequently it consists of the removal of the affected limb if the disease has progressed far, or it may be the removal of diseased bark. There are certain cankers that are more or less common.

New York apple tree canker is caused by a fungus (*Physalospora cydoniæ*) which causes a leaf spot on the foliage, the fruit to turn black, and a canker to form on the bark of the twigs, branches and trunk. A young canker appears as a reddish-brown, slightly sunken area, which turns darker and may die at the end of the season. In some cases the bark is killed and the injured portion shows characteristic, somewhat concentric rings. The dead bark may remain in position for a year and then fall out, showing the wood and a callus along the margin of the injury.

Frost cankers and cankers due to sunscald are serious problems, also the Collar-Rot which is so common on certain varieties and all are difficult to contend with.

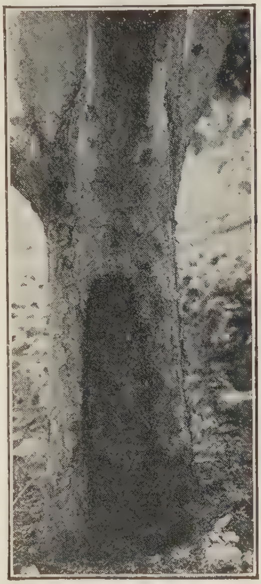

FIG. 62. A Fire-blight canker which started at the collar and spread up the trunk, has been cleaned out and this shows the tree when the work was done. The injured wood is coated with asphaltum paste *Penna. Agr. Exp. Sta.*

Fire-blight canker is the work of the *Bacillus amylovorus.* The canker has a smooth surface and when it ceases to run there is a marginal crack. The "hold-over" cankers, those which remain alive through winter, show no well-defined break, but the diseased bark continues attached to the healthy bark, often showing a purplish discoloration about the points of contact. Fortunately in the eastern part of the United States a large percentage of the cankers die during the winter months. If we eliminate the "hold-over" cankers, those which keep the disease alive over winter, the chance of an epidemic is materially reduced. In California the disease is much more serious, because there is no period of the year when the disease may be said to be dormant; hence its control is a more serious problem. In Pennsylvania it appears that collar blight is due to this bacillus. It is more common on root-grafted trees than on budded trees. Trees are most apt to be infected between the ages of seven and twenty years, twelve to thirteen being the average age of infection. Apple tree borers appear to aid the spread of the disease. Fruit bark beetles, apple aphis and woolly aphis all aid in transferring the organisms. Rabbits, mice and other animals aid in the dissemination. Infected tools may transfer the disease.

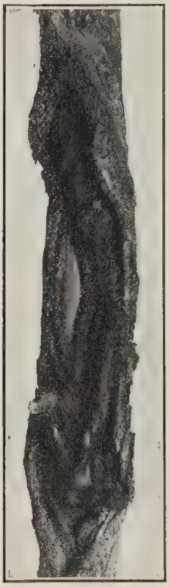

FIG. 63. European Apple Canker, showing layers of callus on the wound
Whetzel & Hesler

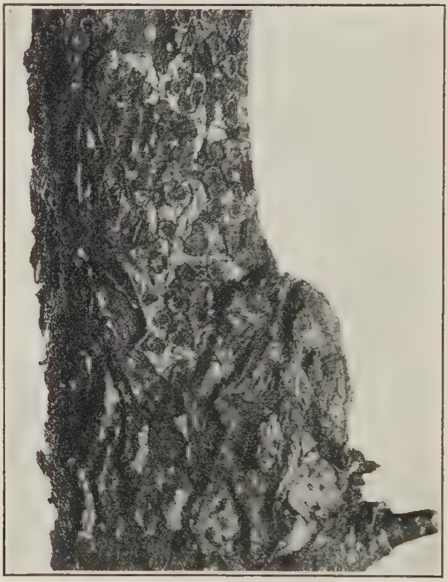

FIG. 64. Blister Canker. The spores are present in the circular bodies seen on the bark *Whetzel & Hesler*

The European apple tree canker attacks many fruits. It is caused by *Nectria galligena*, a fungus which is increasing in importance. The canker begins as a slight discoloration of the bark, which soon becomes depressed. Later the bark above and below the injured area begins to expand, forming a callus along the margin of the injured area; the dead bark then falls away.

The fungus may penetrate the callus and thus cause an increase in the wound. In time, the limb may be involved.

Blister canker is caused by the fungus *Nummularia discreta.* Like the New York apple tree canker it not only attacks the bark but it involves the wood of the tree. The wood of the tree may be practically so much dead matter, but it is essential to maintain the tree in position, therefore, when it is destroyed, the tree goes. This disease attacks the large limbs and the trunk. The fruiting parts of the fungus are large, black and stand out prominently, giving a blistered appearance to the affected part; hence the name. Varieties vary in their degree of resistance to this disease. Ben Davis trees may be dead and Jonathan free from infection in the same orchard. Gano, Delicious and Yellow Transparent also appear to be quite susceptible to attack.

To control cankers. No satisfactory means of control seems to be known. No spray can reach a canker, which is securely protected by the bark of the tree and is progressing in either the sap flow, as in the case of fire blight, or in the cambium layer, as in the New York canker. The only method of control is to cut out the affected area. When a limb is involved and is beyond repair it may have to be cut off. If, however, the disease is taken in time it may be possible to cut the diseased area out. For this work a good draw shave and a farrier's knife are excellent tools. The wound made should extend to healthy wood. It is advisable to make it of such shape that it will heal most readily. A long wound will heal more readily than one more nearly square. The cut surface should be disinfected with corrosive sublimate* 1 to 1000, or in the case of fire blight with cyanide of mercury 1 to 500. Later the wood, but not the cambium layer, may be given a coat of coal tar.

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* The mercury in corrosive sublimate is readily precipitated and if a swab is used to apply the solution it soon loses its value as an antiseptic.

CHAPTER XXI

PICKING AND PACKING THE APPLE

The major portion of our eastern growers fall down in the harvesting and packing of their apples. Indifferently harvested, carelessly handled, roughly thrown onto the table and into the package, a handsome apple soon presents a woe-begone appearance.

The present requirements of the apple markets are: 1. Color—The apples must be so grown that they will show good color, finish, plenty of life, and they must not be picked until they have it. 2. Size—We are growing too many apples on our trees and not securing size. The American people want size. 3. Perfection—We want perfect apples. They must not only be grown well and kept clean, but they must be properly picked and packed, promptly stored and cooled and carefully handled until they reach the consumer. There is no money in producing ordinary apples.

Time of picking. In red varieties, color comes first. Certain varieties drop before reaching maturity, especially in dry seasons. Among such are McIntosh, King, Twenty Ounce and Wagener. Winds will cause others to drop readily when they have reached maturity; among these are Grimes, King, Stayman, Stark, Wealthy and Winesap. Other varieties hang well after reaching maturity—for instance, Ben Davis, Jonathan, Newtown, Rome, Smokehouse and York. The danger is if left too long they become so mellow as not to keep well. The weight given to color in the Pacific Coast states is indicated by the color requirements as shown in the table on page 243.

The use to be made of the fruit. Fruit shipped to market immediately may attain greater maturity on the tree than that for storage. If there is a strong local demand for immediate use, early apples may be picked green before they are mature. For storage the fruit should be taken off barely mature.

As the fruit matures the carbohydrates, mainly sugars, increase, the acidity decreases; the fruit softens, probably due to changes in the pectin which cements the cells together in the green fruit; the skin becomes waxed over and less permeable to water and gases and the lenticels cork over. In the highly colored fruits and on the blushed side the skin is thicker and less permeable than on the green side. Some of these changes cease and others continue after the fruit is picked. The carbohydrate content is at the maximum when the fruit is picked, after harvesting the starch quickly changes to sugar and the change is complete in a few weeks even in fruit held in cold storage. The fruit softens and ripens more rapidly off the tree than will similar fruit remaining on the tree even when held in the orchard or packing-shed at the same temperature.

COLOR REQUIREMENTS OF APPLE VARIETIES

Solid red varieties	Extra fancy minimum color per cent	Fancy minimum color per cent
Aiken Red	75	40
Arkansas Black	75	40
Baldwin	75	40
Black Ben Davis	75	40
Black Twig	75	40
Gano	75	40
King David	75	40
McIntosh	75	40
Missouri Pippin	75	40
Spitzenburg (Esopus)	75	40
Vanderpool	75	40
Winesap	75	40
Jonathan	66⅔	33⅓
Kaighn Spitzenburg	66⅔	33⅓
Striped red varieties		
Delicious	66⅔	33⅓
Stayman	66⅔	33⅓
Ben Davis	50	25
Hubbardston	50	25
Ralls	50	25
Northern Spy	50	25
Rainier	50	25
Snow	50	25
Wealthy	50	25
York Imperial	50	25
Rome Beauty	50	10
Wagener	50	10
Gravenstein	25	10
Jefferis	25	10
Tompkins King	25	10
Winter Banana	10	

To meet these conditions, a Baldwin, for instance, would need to be 75 per cent red to be graded "Extra Fancy," and 40 per cent red to be graded "Fancy."

If picked before maturity and not properly colored, the apple will shrivel and the skin become leathery, the fruit lacks quality and may be quite insipid or be puckery. The fruit is also apt to scald. Red apples will not increase in color in storage, but the color may brighten somewhat. Green apples will turn yellow and the green of red apples will turn yellow.

Starting the picking crew. It is wise to explain to the crew what is expected of them. Usually the more careful growers try to secure the same men one year after another. This plan removes any difficulty that might attend the breaking in of a new crew. All new men should be told what is required. Among others, these things may be mentioned:

(1) Fruit spurs should not be broken off.
(2) Fruit should not be pulled but removed by an upward turn and a twist of the wrist.
(3) The stem should remain on the fruit.
(4) The fruit should be placed in the basket or pail, not dropped in.
(5) Stem punctures should be avoided, since all abrasions permit the entry of diseases.
(6) If there are many pickers, it is well to give each man a number of tags with his number. A tag is placed in the bottom of each barrel or box picked. This gives a record of the picking crew and enables a check to be made of their efficiency.

Ability of the pickers. One Maryland fruitgrower selected two of his best pickers and two of his poorest. After picking up all the apples under twenty trees, he gave ten trees to the two best and ten trees to the two poorest pickers. In the following table are given the results:

Ability of Pickers

	Average yield per tree bushels	Bushels hand picked	Bushels dropped	Per cent dropped	Number of spurs broken per tree
Good Pickers . . .	16.0	15	1	6.4	18
Poor Pickers	16.4	12.6	4	23.4	54

The results convinced him that it would pay to give a bonus to good pickers rather than take a loss of 17 per cent in culls—for this was the same as paying twice for the work.

The ladder. In low-headed trees a tripod (three-legged) ladder may be best. With higher trees, a single ladder running to a point at the top, and spreading at the base, may be most desirable. Ladders with wide tops are difficult to place in the tree. They are likely to break limbs and knock off considerable fruit. For tall trees, anything over 20 feet, extension ladders may be used. It is frequently easier to handle an extension ladder than any other sort of equal length. The bottoms of the ladders should be shod with iron spikes so that they will not slip. Some prefer a ladder which is mounted on a pair of wheels, that may be wheeled to the tree and does not need to rest against it. This ladder is useful also for thinning fruit.

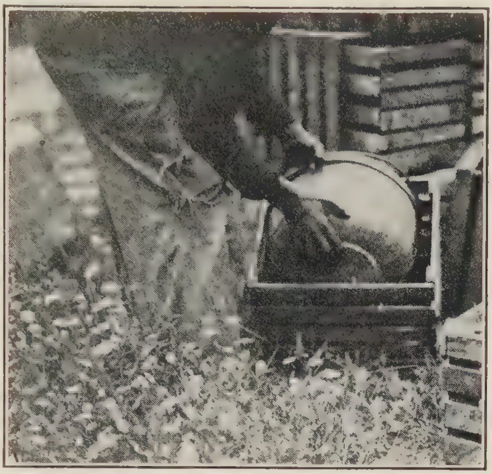

FIG. 65. Emptying the picking basket into the crate. A poor way
U. S. D. A.

Picking bags and baskets. The variety of the fruit, its condition and the degree of ripeness are factors in determining whether to use a bag, pail or basket in picking. Picking bags are frequently used for the ordinary crops of the Eastern states. Western growers and some of the most careful Eastern growers have discarded the bags for baskets and pails. Some baskets are canvas-lined and padded in the bottom that the fruit may not be bruised. The advantage of having pails is that the foreman can hear the sound of any fruit dropped into them.

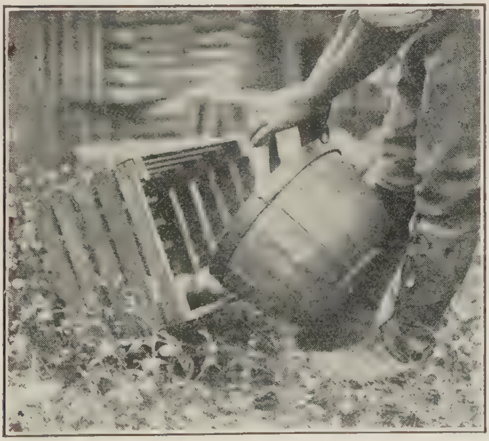

FIG. 66. Emptying the picking basket into the crate. Take care that the apples gently roll into the crate to avoid bruising
U. S. D. A.

Arranging the pickers. It is essential to place the pickers so that the foreman can see what each is doing. Sometimes three rows are picked, the foreman moving around in a restricted circuit. He can then see whether or not care is taken in moving the ladders. If not, limbs may be injured and fruit spurs broken off. The ladders should be so placed as to do the least harm if they lean into or against the tree. Often it is best to put part of the crew to picking the fruit that can be reached from the ground. Others are assigned to the ladders. Where men pick by piece work, each man is given half of a tree and the crew moves in one direction all of the time.

Work of the average picker. Pickers should average from 30 to 75 bushels a day with trees seven to twenty years old, depending upon the crop on the trees and the variety. Many men are incapable of handling over thirty bushels a day. This is probably nearer to the average in the East. Some apples, such as Golden Russet and Fameuse, cannot be picked in competition with Twenty Ounce if the results are determined by the volume gathered and not by numerical count. More work is involved in picking 30 bushels of fruit from tall trees, especially if the crop is not heavy, than in picking 50 bushels on lower trees with a good crop. Picking on hillside orchards requires more work than on trees on level ground. The ladder must be placed with more care and it must be set either up hill or down hill. In the Wellman orchard in New York, on trees forty-five to sixty years old, nine pickers varied from 10.7 to 41.3 barrels per day.

Cost of picking. Taking 218 orchards in Western New York in the years 1910-15, 123 or 56 per cent had the apples picked by the day while 86 or 40 per cent had their apples picked by the barrel. The day men picked on an average twenty loose barrels in ten hours, the piece work men picked twenty-five loose barrels in ten hours. Some men would pick twice the average. The following table shows the matter in more detail:

Number and Cost of Barrels of Apples Picked in Ten Hours

	Records	Ungraded barrels in 10 hours	Man hours per acre	Cost Per acre $	Cost Per barrel cents
Day pickers 20 cents per hour	123	20	54.11	$10.82	12.82
Contract pickers	86	25	41.39	15.06	17.74
All pickers	209	22	48.95	12.57	14.86

The picking cost was 10 per cent of the total cost of production and 33 per cent of the total labor cost. It was from 15 to 20.5 cents per packed barrel, allowing 15 cents for shrinkage, which is a fairly constant factor with a good crop. In Hood River the average time to pick a crop of 222 packed boxes per acre was fifty-six hours. The cost was $12.63 or 3.79 cents per loose box and 5.69 cents per packed box. In the Yakima Valley an average yield of 432 packed boxes per acre required 105.5 man hours, costing $26.38 or 6.11 cents per packed box, and 3.5 to 4 cents per loose box. In Wenatchee the cost was a little lower—5.03 cents per packed box, the average of the record showing 74.6 loose boxes or 49.73 packed boxes per ten hours. In the West, most of the fruit is picked by day labor and the above costs were obtained when labor received $2.25 to $2.50 per day of ten hours.

Lug boxes. Some receptacle should be provided for moving the fruit from the orchard to the packing-shed. In the East, the crop is frequently put into barrels as harvested. These are either covered with burlap and hauled to the packing-plant, or if to be shipped they are shaken and headed. The head is turned that the maximum amount of fruit may be put into the barrel. Care is taken that the apples at both ends of the barrel are not the largest, but preferably the smallest, since they are of the least value.

When packing in the orchard it is frequently customary to put the apples direct onto the table. This was formerly more common than it is today. Some careful handlers in the East have an adequate supply of picking baskets and haul these to the packing-shed as fast as picked. The apples are graded direct from the picking baskets by hand, thus reducing injury to the fruit. In other cases, easily handled and convenient-sized lug boxes are provided. Baskets are not as desirable as the boxes. The slat crate tends to bruise the fruit that comes in contact with the edges. The common box is made of end pieces, seven-eighths to 1 inch, with three-eighths inch sides and bottoms, and holds approximately a bushel. The common sizes of these in inches in the Western states are: (a) 20¼x14x9; (b) 11½x11½x18⅛, and (c) 12x14½x16½—all inside measurements. These boxes are made of rough lumber. A slot is made in each end. At the top of each end a cleat is nailed to protect the fruit when the boxes are piled on each other. Some growers use spruce or pine boxes of finished lumber instead of rough. The shallow boxes give better ventilation; the deeper boxes expose less surface to bruising. The shallow boxes store away easier.

Hauling. For hauling the fruit out of the orchard, wagons should be equipped with springs. Low, wide orchard wagons, with bolster springs, are probably most convenient. The wagon should be capable of turning round in a small radius. It may be equipped with a frame work to hold the boxes. The boxes are piled three to five high, although when the haul is short they are not usually piled. A sufficient number of motor trucks should be provided to keep the fruit hauled as fast as it is picked. Under some conditions these may haul the fruit out of the orchard, under others the fruit may have to be hauled to them on the road. The fruit should not stand out in the sun. It should go to permanent storage as rapidly as possible. Care should be taken that no fruit is left in the orchard over night, or left out during rain. It is not desirable that wet fruit be barreled. Sometimes fruit will get wet; when stored in this condition it should be quickly cooled. If this is not possible it should be carefully watched, and sold if it begins to deteriorate. The pickers will not want to work when the trees are wet, and they should not be encouraged to do so.

Packing a barrel. In the United States and Canada a standard barrel is in use. The Federal law requires that it be branded "Min. Vol. 3 Bus." The diameter of the head is 17 inches, the diameter at the bilge 18½ inches; distance between the heads 26½ inches, all inside measurements. This barrel contains 7,056 cubic inches or three heaped bushels. It contains 105 quarts of fruit. A good barrel should have 16 staves. These should average nine-sixteenths inch at joints and should be cut from 5 inches to 2 inches in width, averaging 4 inches at the bilge. Staves should be free from knots or shakes. The head should not be less than one-half inch in thickness, be dressed, clean and sound. Hoops should be about 1⅜ inch in width, eight in number in the Canadian barrel; six in the American; two hoops at each end and two quarter hoops.

Ventilation. Recently a ventilated barrel has appeared, in which each stave has a thin section taken out of one side about 1 inch below each hoop. This slit is about 3 inches long. There are four in each stave, 64 openings in the barrel. The use of

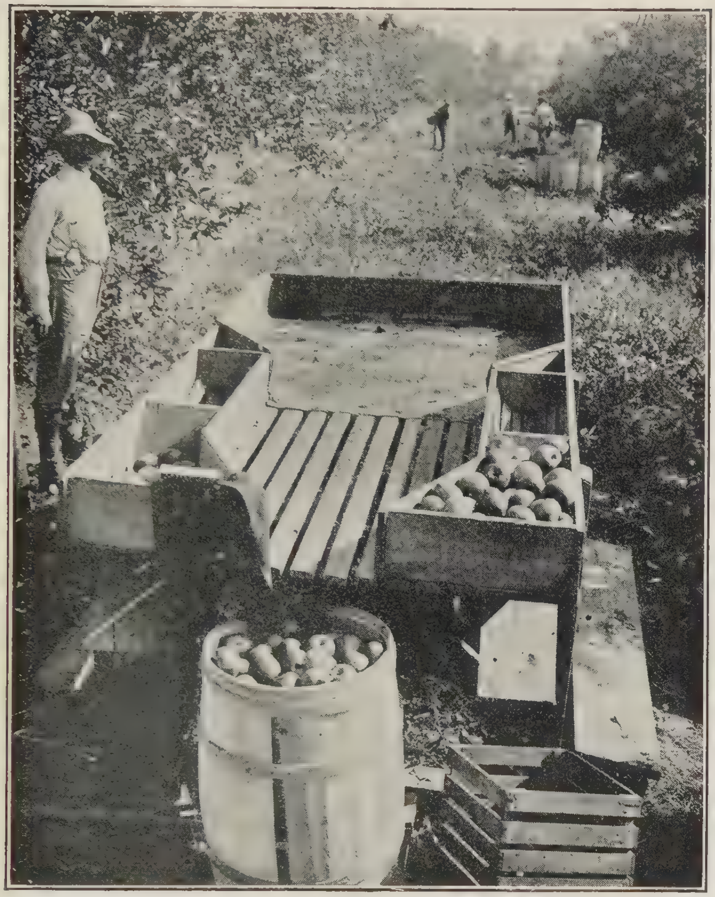

FIG. 67. Packing in the orchard. Sorting table. The back where the fruit is put on is padded, the slats allow leaves and trash to fall through to some extent. The pockets are for the facers and backers. The apron is placed over the top of the barrel and the fruit is run into same, then it is lowered into the barrel

U. S. D. A.

such barrels is advised for tender varieties of apples. which require rapid cooling. It is claimed they will add one month to six weeks to the storage life of such a variety as Rhode Island Greening.

Preparing the barrel for use. As received, there are no nails in the barrel. Before packing, the quarter hoop on one end is driven tight and nailed with two or three three-fourths inch clout nails. Seven-eighths inch nails will go through the barrel and will need clinching. If not clinched, they will injure the apples. The poorest head is left for the face of the barrel. It is nailed after the hoops have been driven tight, with six four-penny nails driven slanting through the top hoop into the head. If headliners are used, three or four nails are used in each headliner, and these are placed at right angles to the joints in the head. Nails are driven so as to go through the staves into the hoops. All export packages are headlined.

Stencilling. The face end of the barrel is stencilled with all required marks, such as grade, size, variety and packer. The barrel is then passed for facing or is placed direct on the racking plank, face end down. If corrugated cardboard caps are used, one is placed in the barrel, corrugated side outward. Sometimes, for fancy fruit a white piece of paper and a lace circle is also put in.

Facing. The barrel is now ready for facing or ''plating.'' Facing consists of placing a layer of apples in rings so as to present the neatest appearance. Each apple is tight in place with no spaces left. The ''facers'' should fairly represent the quality of the fruit in the barrel; in many cases they represent the best. Facers should be of such size that the outside ring will contain from 12 to 18 apples. The second ring contains 6 to 12; the third ring will contain 1 to 6. If the space in the center is not adequately filled an apple should be placed in the center and held in place by three or four apples resting on it. This is much better than filling the space with a very large apple or two small ones. Some expert packers use slightly smaller apples in the outside ring; those a trifle larger in the second ring, and the largest in the center of the face. There is, however, seldom more than one-fourth inch difference in size between the largest and smallest apples, and this order of placing should never be reversed.

The apples are placed stems down. Some careful packers cut the stems of the facers so they may not be forced into the apple by pressure. In other cases the barrel is double-faced—another layer of apples arranged so that they show through the spaces in the first layer. Half a bushel of fruit of above average size apples is now poured in the barrel. These apples are frequently called ''backers.'' The barrel is then ready for filling with the average run of fruit. Attempts are being made to abolish the

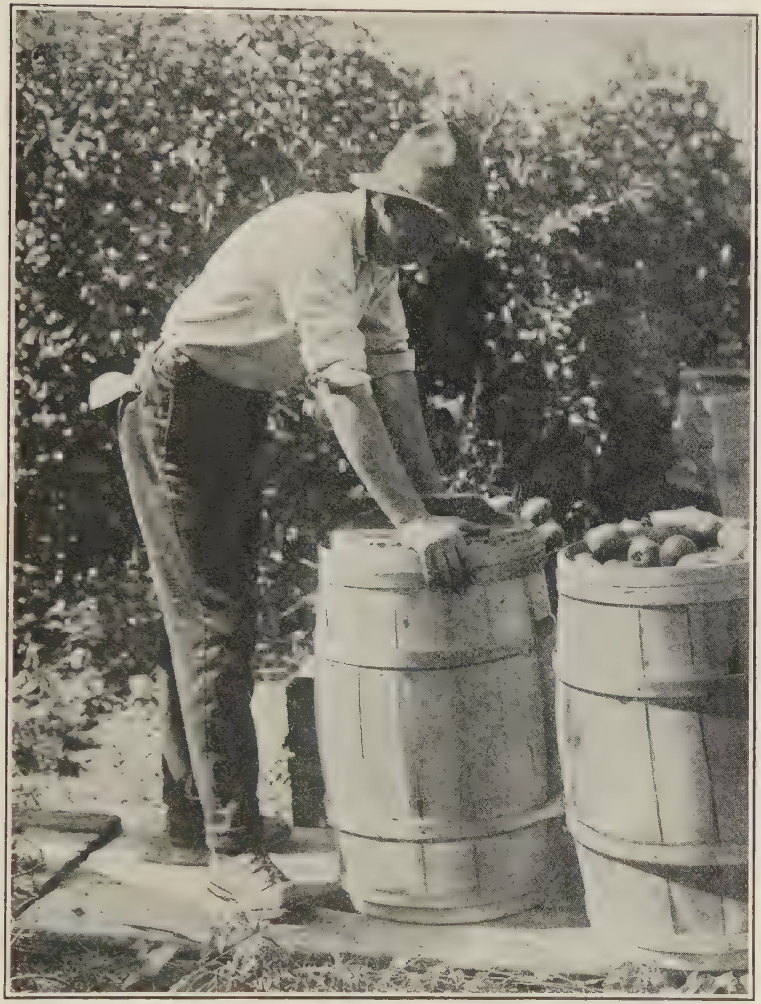

FIG. 68. Racking the barrel. The follower—a padded circular block—is held firmly by the hands which also grip the side of the barrel and by rocking the barrel to and fro the apples are firmly settled. A solid floor is necessary *U. S. D. A.*

"plating" and "backing" and to pack all the apples uniform throughout the barrel.

Filling. Filling may be done by means of baskets, or the apples may be fed directly into the barrel over a canvas. Drop-handle baskets or pails are used, and the fruit is carefully poured into the barrel. Each time a basket is deposited in a barrel, the barrel is given a sharp jar or shake, with a swinging motion; this is to settle the fruit as firmly as possible. This is known as "racking." Where the fruit is run direct from the table, it is allowed to drop onto a canvas which is lowered into the barrel and emptied from time to time. One end of the canvas is nailed to the underside of the table, the other is free.

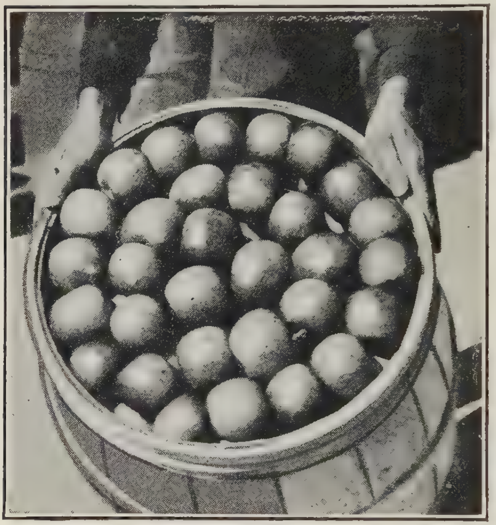

FIG. 69. Tailing the barrel. When racked properly the fruit is settled so that room is left to place one layer of apples, thus presenting an attractive appearance on both face and tail ends *U. S. D. A.*

Racking. Racking should be done on a solid foundation. An inverted stoneboat will serve in the orchard and a concrete floor in the packing-room. Each basketful should be racked into place. If the barrel is half filled without racking, no later shaking will give a tight pack.

Use of the follower. When the barrel is almost full, a round block of wood, often 1½ inches thick and covered with burlap or matting, is placed on top of the fruit and held tight in place by gripping it and the sides of the barrel. The barrel is again racked. This insures a tight pack and usually gives sufficient space for "tailing."

Tailing consists of placing the fruit, stems upward, or on the side in the end of the barrel so that the pressure will come uniformly on all of the apples of that end. If the barrel has been properly racked the apples should project about one-fourth inch above the chine. Barrels frequently become slack from overpressing. Brittle apples such as the Northern Spy will not stand the pressure that might be given the Russets. Apples repacked in winter or spring cannot be pressed as much as in the autumn. Fancy and tender apples as Spy should be protected by a cushion, usually a pad is used on this end.

Pressing. The barrel is now ready for pressing the head in position. In the screw press and the lever press a block of wood is placed over the head and this is gradually forced down by the lever into place. The block of wood which transfers the pressure is placed at right angles to the joints of the head. Large packing-plants are equipped with presses operated by hydraulic or other pressure, which work rapidly.

Heading. In heading, the quarter hoop is slackened, the top hoop is driven off and the second hoop is slackened by driving it up to the place formerly occupied by the top hoop. This allows considerably more space in the barrel. When the head has been forced into position, the second hoop is driven into place, the top hoop is returned where it belongs and the quarter hoop is tightened. A driver made of hard wood is used to force the quarter hoop into place. Special barreling hatches are used.

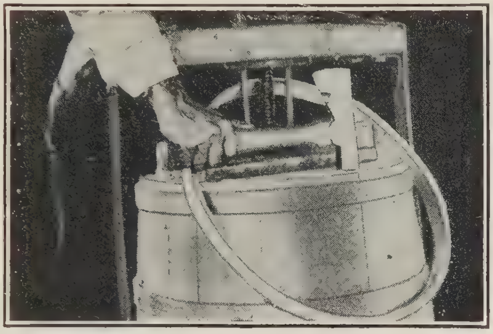

Fig. 70. Heading the barrel with a screw press. The top hoop is off, the second hoop is driven up, to allow the head to go into place. The quarter hoop may also be slackened. When the head is placed all are driven tight. Note the style of hatchet

U. S. D. A.

Nailing. The head is now nailed with four to six nails about 1¼ inches long. If headliners are used, three or four nails are placed in each. The quarter hoop is nailed with three three-quarter-inch clout nails. Care should be taken that no nails are left exposed in any part of the barrel as such are extremely dangerous in handling. If two or three grades of apples are packed at the same time, as is usually done, there should be a place for each size and grade. The headliners should be kept in water or at least be thoroughly damp.

Cost of sorting and packing. The records of 218 Western New York orchards for the six crops 1910 to 1915 inclusive show an average for sorting and packing of 36.72 man hours per acre and a cost of $7.35 or 27 barrels per man per ten-hour-day. This is almost 9 cents a barrel. The variation was from 7¾ cents to 10 cents. The cost in 1915 in Hood River, Oregon, on 54 farms was 3.2 cents per packed box, or 2.1 cents per loose box for sizing the fruit when a sizer was used; 4.6 cents per packed box, or 3.1 cents per loose box when sorted by hand. Packing cost 4 cents per packed box when the fruit was sized and graded for the packer and 5 cents when the apples were graded but not sized for the packer. The average packer packed 77.5 boxes per ten-hour day. In Wenatchee, the average cost of packing the fruit in 87 orchards in 1914 was 8.7 cents per packed box. Labor was paid $2.25 to $2.50 per ten-hour day. In 1915 in Yakima, Washington, eight growers out of 120 sorted and packed for 6 cents per packed box. The average of nearly 100 others was 4.14 cents for sorting and 5 cents for packing, a little over 9 cents per packed box. With the expenses of nailing and incidentals a packed box cost 10½ to 11½ cents. For comparison 3 boxes about equal a barrel.

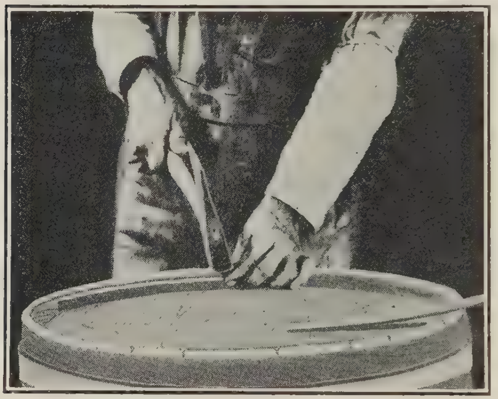

FIG. 71. Headlining a barrel. The headliners are kept in a pail of water and are nailed into place—at right angles to the joints of the head while wet, with three or four nails driven slanting to catch the hoop

Points worthy of mention in packing. Handle apples as little as possible. Strong protest should be made against the habit of throwing fruit on the table or handling it unnecessarily. When fruit is sized the motion of the fruit on the machine should be steady, not too rapid. It must not be bruised. Keep the place clean. Keep the barrels clean. If packed in the orchard, get under cover as soon as possible. If the barrels get wet the hoops may break. Fruit placed on the market in a barrel which looks like a second-hand package is discounted. In packing it will pay to open a barrel from time to time to see if there is sufficient spring in the fruit. If on removal of the head the fruit rises above the chine the barrels are properly filled. If fruit is held in storage a month, each barrel should be opened before shipment to see whether it has shrunk and whether it is necesary to put in a cushion to take up the slack. The cushion is put in on the tail end.

Use of second-hand barrels. The high price of packages often forces the consideration of second-hand barrels. For fancy fruit, the best package is none too good. For average fruit, especially if sold before shipment and the buyer knows he is to get second-hand packages and is satisfied, the use of second-hand barrels is justified. Usually the buyer makes a discount in prices when they are used.

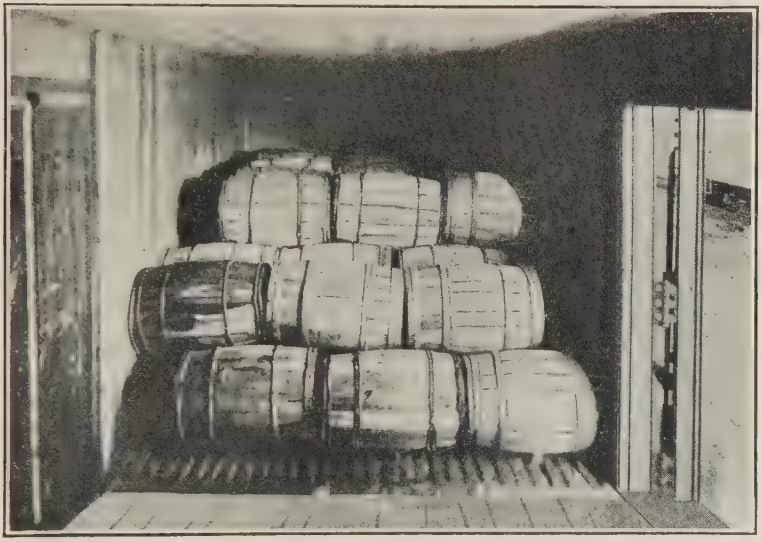

FIG. 72. Loading the car with barrels of apples, showing the "alternating straight" method. All the barrels of any one layer are placed tight against the same side of the car, the next tier against the other side, the third tier over the first. When shipping under refrigeration this method is preferred because it allows currents of air to move the length of the car *U. S. D. A.*

Loading the car. Lay the barrels crosswise of the car. The width of the car will allow three barrels placed end to end. Pack all the barrels on the bottom tier tight against one side of the car. Pack all those on the next tier tight against the other side of the car. Pack those in the third tier as in tier one and those in the fourth tier as in tier two. This will cause the barrels to nest with the center of the bilge over the four heads of the barrels immediately under it. This is the best system of loading the car, especially if shipping under refrigeration. It allows the cold air to pass along the fluelike openings.

The barrels should be tiered to their full height at the ends of the car working towards the doorway. Blocks of wood or stones are used to hold the lower barrels in place while they are being piled. These must be removed; otherwise if the barrels shift at all the stones or blocks may cause broken staves and damaged fruit. If the barrel spaces do not come out uniform at the door, two barrels may be used as wedges in each layer, the bilge being placed between the heads of the barrels below them. They should be left so that they wedge the load tight.

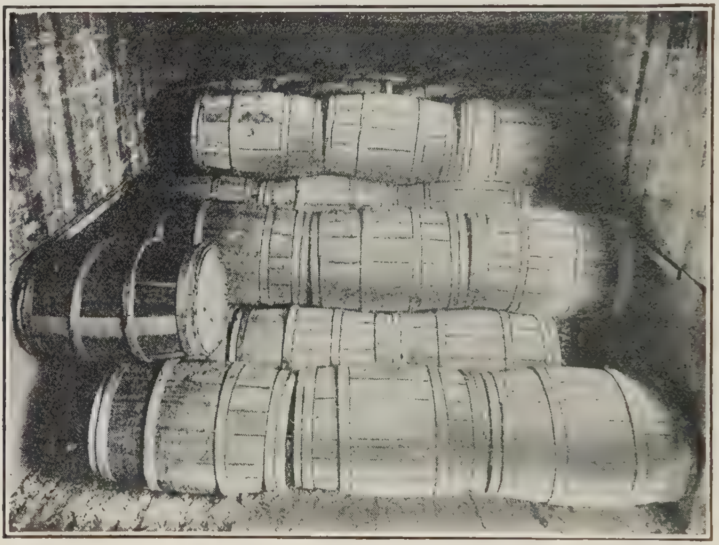

FIG. 73. Loading the car showing the "staggered" method of placing the barrels. This is preferable when shipping in cold weather. There is not the tendency to induce the formation of currents of air *U. S. D. A.*

Position of barrels in hauling. When barrels are hauled to storage without heading and are merely covered with burlap they must be carried standing upright. Much fruit is handled in this way, particularly when hauling to a central packing-plant. Headed barrels, when hauled, are laid on their sides, lengthwise or crossways of the wagon. The wagon should have proper springs. Since many of the hauls are long the use of trucks is increasing in the movement of the crop.

Cost of hauling apples. The United States Department of Agriculture reports the average length of haul for apples to loading point for 114 counties as 9.6 miles. The average cost of hauling a barrel previous to 1914 was 19 cents, or 2 cents per mile per barrel. This has an important influence on the location, much greater than is imagined. With an average yield of 50 barrels per acre, which is obtainable in a good region, and an average haul of five miles, a cost of 10 cents per barrel is involved for haulage, or $5 an acre rent. In other words, with interest at 5 per cent, it would be as well to pay $200 per acre for land on a railroad track alongside of a switch as to pay $100 an acre for land equally good, situated five miles away. But the benefits are not confined to this one item. The advantage of quick despatch and ability to load from cold storage on track into the car without intervention of a wagon or truck is considerable to the grower who handles apples, pears, peaches, and other fruits or perishable commodities. The present cost of trucking is high and the difference becomes of more importance as time goes on.

AVERAGE COST OF HAULING APPLES PREVIOUS TO 1914

Geographic Divisions	Counties reporting	Miles to shipping point	Days for round trip	Pounds in one load	Cost per load	Cost per 100 lbs.
North Atlantic . .	40	7.9	.7	2490	$2.53	$0.10
South Atlantic . .	18	10.5	1.0	2584	$3.18	$0.12
North Central . . .	31	8.5	.8	2267	$2.26	$0.10
South Central . . .	18	13.8	1.2	1617	$3.11	$0.19
Western . . .	7	13.7	1.8	3558	$8.36	$0.23
Total . . .	114	9.6	.9	2300	$2.79	$ .12

The basket. The round bushel basket is used largely for summer apples and its use is growing both East and West for all fruit. Fruit is usually poured in after it has been sized. The grade is usually marked on the package. In some instances the top is ringed in a manner similar to that used in tailing a barrel. A corrugated cap is put on the top and the cover is held down by the handles. The baskets are loaded as outlined for peaches. The 4 by 4 diagonal loading is generally preferred.

The tub, holding a bushel and having a removable top and bottom promises to replace the bushel basket in certain markets.

Bushel hamper. In some markets there is a strong effort made to push the use of the bushel hamper. A hamper has been devised with a removable bottom so that the top layer may be faced just as in a barrel. Whether this package will make any headway or not will depend on the public. The hamper loads well in the car. It is placed top on top to the height required. The next baskets are placed in reverse order. In this way the first row of baskets placed across the end of the car shows alternately the top and bottom of the basket and in the next tier the order is reversed.

Half-barrel box. In the East, there is an attempt to use a half-barrel box or crate. Such a box is coming into favor for cranberries. It is well made, much heavier than the western box. The face is plated as in the case of the barrel. The apples are then put in jumble pack and the cover is pressed into position. The advantages of the box over the barrel are: 1. In the store it may be set on edge, displaying its contents until it is empty. Customers in a store do not see a barrel when it is half full. 2. It is a smaller package. A barrel is more than most stores want. They prefer a fresh supply daily. 3. A stout box will not need cleating in the car and can be used for express shipment.

CHAPTER XXII

SIZING MACHINES AND GRADING

For many years orange and lemon growers have sized and graded their products. They succeeded in persuading the public to buy fruit by count; also they succeeded in standardizing the price of oranges to a degree. When oranges are high the grocer merely substitutes a smaller size of fruit, and when cheaper he delivers a larger size. It may be 35 cents or 60 cents a dozen. It was, therefore, only natural that the western fruitgrower should attempt to do the same with his apples.

The first large commercial attempt to grade apples and pears to a uniform size was made on the Pacific Coast. This was due to two reasons: It was the custom with oranges and other fruits, and only the best fruit could be shipped with profit. Grading and sizing fruit by hand is expensive. Once there was an adequate supply to warrant the expenditure, machinery was developed as a necessity. The danger with machine sizing is injury to the fruit. Some of the best packers both East and West size by hand, but the average commercial pack of fruit is sized by machinery.

Sizing. Among apple growers of the Western states all grading and sizing was done for the purpose of putting the apples into boxes. Very little variation is tolerated in the size. A certain specified number of a definite size is put in layer by layer and every layer is alike. The face of the package represents the whole. In the eastern and central parts of the United States apples are packed in barrels, bushel baskets, hampers or perhaps in some open package as a crate, or they are shipped in bulk. In normal years this embraces a large portion of the apple crop. It was only recently that any system of sizing the fruit came into common use. The custom has been to put large apples on the face of the barrel and completing the fill with apples ranging from that size down to any size the grower thought wise to put in. So long as this satisfied the trade it was perhaps the best way to size.

Present method of sizing. Today, in most of the important states, the minimum size of the fruit must be stamped on the barrel, this will soon be adopted in all states. Many growers limit the size of apples to one-fourth inch variation in the barrel. Thus, the apples may be 2 to 2¼ inches; 2¼ to 2½; 2½ to 2¾; 2¾ to 3 inches, and those above 3 inches. Or the apples may be packed 2½ inches and up and 2 to 2½ inches. This method of sizing is rapidly training customers to ask for apples of a certain size. The man who runs a large baked-apple trade wants the largest size; he does not want a 2½-inch apple, he wants nothing under 3 inches. A 2-inch apple that is absolutely clean and well-grown is just as much a No. 1 apple as the 3-inch, and for dessert purposes an apple of the smaller size is generally preferred. The size and the grade are distinct. The grade may be Fancy A, B or C of any size. The terms Extra Fancy, Fancy and Choice or C grade are used for box apples.

Number of apples in a barrel. Taking several of the standard varieties of apples such as Black Ben Davis and Rhode Island Greening, the indications are that the approximate number of apples in a barrel is as follows: 2-inch, 900; 2¼-inch, 747; 2½-inch, 595; 2¾-inch, 453, and 3-inch, 320. The assurance to the retailer that a barrel of fruit contains so many apples of a certain size, enables him to sell them by count and he knows just what he can make as he can from a box of apples. The grading laws enacted in various states are of value, for they tend to establish confidence in the industry, of which there is need. In addition they have forced men to more economical ways of handling the crops. The present system of using mechanical sizers has reduced the cost of packing apples from 30 to 50 per cent over the hand methods, for the simple reason that wherever there is machinery running at a standard rate the men must move at that rate all the time. The empty machine is easily seen and the work is speeded up.

Some types of graders. Among the important machines is the link-belt type. The essential parts of this machine are certain pieces of endless link belting. The apples are passed over the belts and either fall through the openings or are carried over, according to their size. As now arranged, the apples are poured on a conveyor belt. Men and women stand along the sides of this belt and remove any imperfect apples, putting them on a belt conveyor running in front of them. These rejected apples are taken away to the dryer or canning factory. The selected apples are carried over 3-inch links, every apple under 3 inches falls through. The 3-inch apples left on the screen are carried along on another belt and barreled. Those that have dropped through are passed over a 2¼-inch screen to get rid of all the small ones and the remainder then goes over a 2½-inch screen to take out all 2¼ to 2½-inch size, which fall onto a conveyor or into a pocket. The 2¾ to 3-inch size pass on and are barreled. This system is perhaps 90 per cent correct and lends itself very well to a community packing-house in the East.

Eastern community packing-house. One of the best of these is owned by D. N. Minick & Brother, of Biglerville, Pa. Fruit from each of twenty-three growers is deposited on the platform of the packing-shed in a certain designated place, each man having his own location. An endless belt carrier runs the length of the packing-shed. The fruit is put on this and run over a 2¼-inch screen first, which takes out all small apples. While on the belt conveyor, all imperfect and injured apples are picked out and placed on a belt carrier which takes them with the small ones to the cannery so that nothing but barrel stock is carried very far. The apples then pass over 2½-inch, 2¾-inch and 3-inch screens and are carried by belts running at right angles to the men who are barreling. In order to save loss of time there are padded pockets capable of holding ten barrels at each station, a station for each size of fruit. Thus, it is possible to start to grade a second lot of fruit before the force has finished working on the first. A single machine of this type will handle 800 barrels a day, or four full cars. Fifteen to twenty men are required.

Hand-power machines can be secured to put up a car a day. The small grower with a few cars cannot afford to be without such a labor-saving machine. The patent in these machines is the link belt. The conveyors can be purchased from belt-conveyor makers, and the machinery adjusted to the local conditions. There are various types of link belting which have been developed to do this work, the variation consisting in the shape and method of manufacture of the link itself. This method of grading is not perfect, but it is rapid, and although its appearance would lead one to fear that the fruit might be injured it has thus far proven quite successful. The secret is to be sure that the fruit moves slowly, that it merely turns as it leaves one conveyor for another, and does not roll rapidly or fall.

Roller type. Another sizer consists of a pair of rollers which revolve, turning the fruit around. These rollers are adjusted so that the space between them increases in size from the top downward. In this way the 2-inch apples drop out first, then the 2¼-inch and so on to the end. Some of these are capable of handling up to two cars or 400 barrels in a day. The Burke grader was the forerunner of this type. It is the standard machine for sizing peaches and is used in all the packing-plants of the Island section in Ohio. It is one of the most satisfactory machines for handling peaches. It is relatively inexpensive. With a double roll machine, one capable of handling two streams of peaches, four women and one man will handle a bushel a minute. Another type consists of cups or pockets. In this is a wooden belt, the pockets of which increase in size as they travel. The fruit is carried in these pockets and is dropped when it reaches the bin in which it belongs. Another type sizes the fruit by carrying it along a slot. It falls through when it reaches an opening wide enough.

Graders for box fruit. For box-packing and for grading fruit irregular in outline, as for instance, pears, one of the western machines is equipped with a double run. The fruit is placed on the runway by hand, being inspected before it is allowed to pass. An upper runway carries off any fruit which is not sound. The machine is so arranged that there are nine pockets on each side. Highly colored fruit may be put on one side and light-colored on the other. Eighteen different sizes can then be made. The fruit is sized by weight. A specimen of the weight desired is deposited in any given compartment being placed in a pocket near that compartment. When fruit of that size reaches its equal in weight it is automatically tripped and falls in that compartment. This machine will handle a thousand bushels a day, at a cost of 2 cents per box. A 1/4-horsepower motor will run it. It costs $300 to $500. It can be used for all classes of fruit and even potatoes. There is a growing demand that potatoes be graded according to size. Another sizer well adapted to large orchards has two runs, and makes seven sizes in each, these varying by one-eighth inch. Fancy fruit goes down one run, extra fancy down the other. It places the apples in the boxes automatically and does good work in the jumble packing of boxes. It takes six to ten women on each side to sort out the defective fruit, which is carried away on an endless belt. It is claimed that a box of apples can be sized, graded, packed and loaded into the car for 4 cents or less with the aid of this machine, if the fruit is of good quality.

The United States Department of Agriculture has devised a peach grader which it is anticipated may be used for other fruits. Working plans of same are for sale. The estimated cost of the machine is $450. It can size two or three cars of peaches in a day with the aid of ten to fifteen hands. The peaches are deposited on an inclined roller conveyor, which turns them so that all sides of the fruit can be seen without touching. The sorters standing at the side remove any imperfect fruit. From this conveyor the fruits are delivered to two sets of ropes which run over pulleys. These ropes diverge and can be adjusted as needed. The ropes are given a slight decline and the fruit passes along until it falls through. The fruits are fed singly onto the ropes, which limit the capacity of the machine.

As an illustration of the interest of this subject and the small sum which needs to be expended on a machine, the Starcher grader devised by Dr. G. C. Starcher, of the Virginia Station, Blacksburg, Va., is of interest. This machine can be made for $15 and is adequate for one having a limited quantity of fruit. Blue prints and photos are on sale at this station.

The development in grading machines, or perhaps they should be termed sizing machines, may be expected to be rapid. The types mentioned above may be out of date in a very short time. The principle of grading and sizing is good; it encourages honesty. It has proven to be an economical way to handle the crop. Fancy fruits of varieties with a tender skin are best sized by hand.

Result of grading apples in Canada. Canada has a grading law and a system of inspection of apples at the port of export. There are three grades recognized—1, 2 and 3. MacMahon of Nova Scotia, who sells the fruit of a co-operative association comprised of forty local organizations, gives the returns for the three years 1912, 1913, 1914 as follows:

Average Returns Per Barrel to Growers in Nova Scotia

	Grade No. 1	Grade No. 2	Grade No. 3
Gravenstein	$2.21	$1.86	$ .89
Blenheim	1.95	1.60	.92
Ribston	1.68	1.47	.83
Tompkins King	2.37	2.02	1.16
Wagener	2.19	1.82	.79
Stark	2.47	2.02	1.25
Bellflower (Bishop Pippin)	2.34	2.00	.92
Rhode Island Greening	2.25	1.81	.90
Fallawater	2.38	2.01	1.32
Baldwin	2.36	1.88	1.11
Golden Russet	3.45	2.88	1.96
Spy	2.58	2.13	1.13
Gano	2.42	2.00	1.48
Ben Davis	2.35	1.93	—
Russet (Nonpareil)	2.90	2.55	—
Average per barrel	$2.39	$2.00	$1.13

	No. 1	No. 2	No. 3	Culls	
MacMahon estimate of percentage in each grade in the case of a good grower, crop 100 barrels per acre is . .	60%	20%	15%	5%	
Value	$143.40	$40.00	$16.95		$200.35
Ordinary orchard crop, 80 barrels not given best of care.	25%	15%	50%	10%	
Value	$ 47.80	$24.00	$45.20		$117.00

In Hood River, Oregon, in 1919, the Apple Grower's Association packed 1,322,268 boxes; of these, 53 per cent packed Extra Fancy (the highest percentage ever attained); 32 per cent packed Fancy, 15 per cent packed C grade. The value of the different sizes and grades is illustrated by the average returns secured in 1920 on Spitzenburgs.

AVERAGE RETURNS OF HOOD RIVER SPITZENBURGS

	Extra fancy	Fancy	C grade
4 Tier	$2.08	$1.83	$1.58
4½ Tier	1.78	1.53	1.28
5 Tier	1.48	1.23	.98

These figures forcibly illustrate the importance of size as well as grade.

CHAPTER XXIII

THE BOX PACK

The box is essentially a western package. The lumber available in the West lends itself to box-making. The package is now established in the trade except in isolated regions. The barrel is recognized as the standard package for the East. The same quality of fruit will make just as much money in a barrel as it will in a box. If barrels remain high-priced, it will lead to the use of some other package in the East.

The standard box is 10½ by 11½ by 18 inches, inside measurement. The ends are five-eighths to three-fourths inch; sides one-fourth to three-eighths, and the top and bottom are three-sixteenths to one-fourth inch. The top and bottom are made in two pieces each. The sides and ends are in one piece. Four cleats are used, one for each end of the top and bottom. Boxes are usually purchased knocked down or flat, and prices are quite variable, having ranged from 10 to 25 cents each. For export the ends of the box must be wired or strapped. This strengthening of the box improves it, but does not prevent breakage. The American box weighs 6 to 7 pounds, while the Australian package weighs twice as much and with these there is no breakage. The Australian box has no bulge.

Nails. Four-penny, cement-coated box nails are usually used in making the boxes. A form is usually made where many boxes are to be made up. One side is nailed on the ends and then the other side. Box-nailing machines are employed wherever a quantity of boxes are made. Cleats should be soaked in water before nailing to prevent splitting, and where a nail stripper is provided it arranges the nails with the heads up. A man can nail from 400 to 750 boxes in a day. The box material is usually spruce or pine dressed on one side. It should be clean, bright lumber, free from knots.

Lining the box. The boxes are usually lined with light tough white news sheet paper, two sheets for each box. The paper is usually placed so that one sheet covers about two-thirds of the bottom, extending up the side and is bent back over the side of the box. Another sheet is placed on the opposite side, overlapping the first on the bottom. The papers overlap on the top of the fruit. A small fold or plait is usually made in the paper at the bottom so that it will not be too light and tear. Papers are usually cut 17¾ by 27 inches, or 18 x 26; 7½ pounds of liners are needed for each 100 boxes, or 50 pounds for each car of fruit, the average car being 756 boxes.

Wrapping paper. Most of the boxed fruit is wrapped. This keeps fruit from bruising, makes it easier to pack, keeps it clean, prevents the spread of decay from one apple to another and makes a more attractive package. A light smooth manila paper, glazed on one side, is placed with the rough side next to the fruit. The wraps vary with the size of the fruit. Some establishments stamp their name or brand on each wrapper. The use of oiled paper to prevent scald is now in general use.

Papers 8 by 8 inches are used for apples, 150 or less to the box; 9 by 9 inches for apples running 112 to 150; 10 by 10 inches for sizes 150 to 172; 11 by 11 inches for larger sizes. The cost of the paper for a box in 1914 was 3½ cents a box. In 1919 it had more than doubled, in 1920 it was still higher.

The amount of wrapping paper required. A standard car of 756 boxes will require:

16 pounds to the ream, or 50 pounds for 90 boxes;
14 pounds to the ream, or 50 pounds for 120 boxes, and
12 pounds to the ream, or 50 pounds for 140 boxes.

On the average, 50 pounds of paper are needed for 100 boxes or 375 pounds of wraps per car.

Packing-table. The common size packing-table is 3 feet by 4 feet, holding three to four bushels. The height is 38 to 40 inches. The materials required are:

Six pieces of 1 inch by 6 inches and 4 feet long; two 4-foot sides; two 3-foot ends with 1-foot projections on each box rest and two boards to fit crosswise under the table and project 1 foot to furnish a rest for the other end of the box. Four pieces, 2 inches by 4 inches by 38 inches for the legs; four pieces one-half inch by 3 inches by 5 feet for side braces; four pieces one-half inch by 3 inches by 4 feet for end braces; one piece of canvas or burlap 3½ feet by 4½ feet to cover the top and tacked down over the sides.

The inner corners of sideboards and leg tops should be beveled to eliminate sharp projections and thus avoid bruising fruit when it is poured on the table and wearing holes in the canvas. A second burlap is often used to fasten over the first canvas or burlap at one end. This may be thrown back and shaken easily to remove dirt and leaves. In making the table the projecting ends should extend out to the right, or the box will be on the wrong side of the packer. It is well to have one table with ends extending to the left, however, to accommodate left-handed packers.

The paper hod. This is usually a tray about 2 inches deep, open on one side, 11 by 12 inches. It has two bent wires extending out on one side by which it is hung over the edge of the box. An attachment on the under side holds it in position by resting against the side of the box.

The press. A box press is indispensable. It may be constructed at home or purchased. It has two arms which hold down the two ends of the cover simultaneously and hold the cleats in position, giving plenty of room for the insertion of the nails. These arms are worked by a foot press. The press is located near the packing-tables so that a roller conveyor takes the fruit from the packer to the press.

Wrapping the apple. It requires practice to get a smooth wrap and do the work without making unnecessary movements. The description as given by Professor Mason is as follows:

> "The paper is picked up in the left hand, the thumb being about 2 inches from the corner of the paper and the little finger on the opposite corner of the paper. Simultaneously the apple is picked up with the right hand and thrown on its cheek into the center of the paper in the left hand in such a position that the thumb-joint will fall into the stem cavity. Keeping the crotch between the thumb and fingers of the right hand as low as possible, draw up the three loose corners, turn the apple over in the palm of the right hand, which is flattened out as the turn is made thus twisting the ends of the paper in a pad over the cheek and stem; slide the apple off into its place in the box, where the placement of the apple prevents the paper from unfolding. At all times the apple is held by the left hand and when the wrap is complete it is still in the left hand. There should be no juggling of the fruit from one hand to the other, as all unnecessary motions slow up the wrap and lower the day's output. When practiced, there are just three movements in the above wrap: the first, with which the apple is thrown into the left hand; the second, with which the paper corners are drawn up and the fruit simultaneously turned over; and the third, with which the apple is made to slide into its place in the box. This is not the only wrap. Any quick and efficient method is just as satisfactory."

Filling the box. There are several packs. The best is known as the diagonal. For large apples, that is for sizes 96 or larger, the 2-2 pack is used; for smaller apples, the 3-2. In packing the 2-2, the first apple is placed in the corner of the box, the second in the center of the remaining space. The third apple is placed over the gap, between one and two and the fourth apple over the gap between two and the side of the box, then place five and six and fill out the tier in the same way. The apple rows are diagonally across the box.

Keep the following points in mind: (a) The tops of all apples should be uniform and level. (b) If one apple is slightly lower than the others the pack will be thrown out of line. (c) The alignment of the shoulders of the apple should be correct.

(d) If properly done there will be just room for two apples to be slipped into place, with slight crowding. Before placing these run the hand over the apples, pushing them down into their place. (e) The beginner is cautioned against pushing each apple into place. Each apple should be laid gently in place and not firmed until the upper end of the layer is reached. This will result in a smooth pack.

In packing the 3-2 pack, proceed as with the 2-2 pack, except that three apples are placed in position then two as before. The rest of the work is as per outline. The square pack, in which the apples are placed directly above one another is not regarded with favor because the apples are more apt to be bruised. The offset pack has also been discarded since all sizes can be packed diagonally.

Placing the second tier. In this tier the first apple is placed in the depression between the end of the box and the second apple of the first tier. It should cover just half of the apple beneath it, if it covers more it is too large. The arrangement then follows that given for the first tier, the apples nesting in the spaces between those beneath. If the apples appear loose, they are too small; if too tight, they are too large. Keep all apples alike, do not put large ones in the middle to make a bulge.

The bulge. An expert packer will put a bulge on a box using apples of the same size throughout. The bulge should be from 1½ to 2 inches if the boxes are for shipment in carlots and the variety is a late keeper. For express shipments the bulge should be low or the apples will be injured in transit. Apples packed for early consumption do not need so high a bulge.

Marking and nailing. When filled, the box is set on the nailing press. Before fastening the cover it is stamped on one end with a rubber stamp, designating the variety, grade and number of apples in the box. The cover is then nailed on and the box sent to storage or to the car. The box is always moved on its side. It is never placed on its bulge until it is ready to be opened.

Strapping. Ullage and the heavy breakage in the boxes exported caused British railroad and shipping officials, upon whom the final movement of the boxes devolved, to make representations to growers and shippers so that now all boxes for export are strapped at each end. This with more care in loading and unloading has materially reduced the losses.

COMMERCIAL APPLE PACKS IN STANDARD BOX

Inches: diameter (approximate)	No. apples in row	No. apples in box	Number layers	Pack	
3½-4	5-4	41	3	2-1	Diagonal
3½-4	5-5	45	3	3-	Straight
3½-4	6-6	54	3	3-	Straight
3 -3½	4-4	64	4	2-2	Diagonal
3 -3½	4-5	72	4	2-2	Diagonal
3 -3½	5-5	80	4	2-2	Diagonal
3 -3½	5-6	88	4	2-2	Diagonal
3 -3½	6-6	96	4	2-2	Diagonal
3 -3½	7-6	104	4	2-2	Diagonal
2¾-3	4-5	113	5	3-2	Diagonal
2¾-3	5-5	125	5	3-2	Diagonal
2¾-3	5-6	138	5	3-2	Diagonal
2½-2¾	6-6	150	5	3-2	Diagonal
2½-2¾	6-7	163	5	3-2	Diagonal
2½-2¾	7-7	175	5	3-2	Diagonal
2½-2¾	7-8	188	5	3-2	Diagonal

Cost of boxing. The approximate cost of handling apples in boxes from tree to warehouse may be judged from the following table, taken from Oregon Station Bulletin No. 132:

COST BOX APPLES, FROM ORCHARDS TEN TO EIGHTEEN YEARS OLD
From Tree to Warehouse—box unit costs in 1915.

Item	Under 11 acres	Per cent of total	11-25 acres	Per cent of total	26-50 acres	Per cent of total
Picking . . .	$0.0419	12.8	$ .0479	14.6	$ .0400	13.2
Hauling . . .	.0137	4.2	.0182	5.6	.0200	6.6
Packing . . .	.0450	13.7	.0499	15.1	.0400	13.2
Grading . . .	.0375	11.5	.0386	11.7	.025	8.2
Box made up . .	.1021	31.2	.1167	35.5	.110	36.3
Paper	.0378	11.5	.0329	10.	.0375	12.3
Incidental . .	.0495	15.1	.0249	7.5	.0310	10.2
Total . .	$0.3275	100.	$0.3291	100.	$0.3035	100.

The expense of handling apples is from 30 to 35 cents a box. The late E. H. Shepard, Editor of *Better Fruit*, gave the following table (on page 270) of handling costs on his crop of 5,520 packed boxes:

Item	Cost	Per cent of total
Packing	.04	12.5
Picking	.0546	17.1
Grading	.0321	10.1
Making boxes and nails	.01	3.2
Overhead hauling	.0087	2.4
Associated hauling	.0205	6.4
Help in packing-house	.0086	2.7
Knock-down box hauling	.0025	.8
Nailing covers and stamping	.0096	3.0
Box	.09	28.2
Paper	.0331	10.4
Superintendent	.01	3.2
Total	$0.3197	100.0

For the next few years costs will be higher than those given above, but the orchardist can use these items for comparative purposes. Labor and lumber are fluctuating in price and the same is true of paper.

Loading the car. In shipping, the boxes are placed on the side with a space of 1 inch between them. One row is laid across the end of the car, the boxes lengthwise. A slat 1 inch wide and one-fourth inch thick of the length across the car is nailed on the side of the boxes over the ends with a three-penny nail driven in each box. The second layer of boxes is then placed over the first and similar strips are used, and so on to the height necessary for loading. Both ends of the car are filled. A spreader is placed in the doorway and by means of a screw press the boxes are forced against the ends of the car so that there can be no sliding. Braces of 2x4's are then nailed in place so that the boxes will be held firmly in position. Usually a space of 3 or 4 feet is left empty between the doors. In the case of refrigerator cars, the cars may be iced and shipped, 630 boxes being the minimum in a small car, and 756 the common load. Twenty-two hundred boxes have been loaded in an automobile car. The loads in box cars are uniformly greater than those of refrigerator cars.

Desirable sizes. Large-sized fruits as 36's and 45's are generally undesirable, except for exhibition purposes. In Spitzenburg and Delicious, 72 to 96 will usually bring the highest price, but with most varieties the American trade as a whole seems to prefer fruits which pack 100 to 125 to the box, or apples about 2¾ to 3 inches in diameter. For export purposes there is a tendency to ship somewhat smaller fruit. The baking trade takes the 72 to 96 size.

CHAPTER XXIV

STORAGE

Before man cultivated plants, he stored the fruits he gathered. Storage, therefore, is as old as civilization. At the present time common storage is known as dry storage to distinguish it from cold storage. In cold storage is provided more or less suitable accommodation for holding the products, and the temperature is controlled more or less absolutely, either by mechanical means or by the use of ice.

Essentials for successful storage. A most important factor in extending the storage of fruits has been the discovery of methods to control insects and diseases. In many cases the injuries caused by insects and diseases preclude all possibility of successful storage, so that today in order to store successfully one must have fruit which has been well sprayed and is clean. It must be gathered at the right stage of maturity, neither too green nor too ripe. It must be handled expeditiously and not allowed to become heated or exposed to the sun after being picked. It must be put into suitable packages to permit of rapid cooling, for it is recognized that fruit is a living thing and that immediately upon separation from the plant it must live upon the food stored within itself. It has to breathe; it must maintain a certain degree of heat and utilize a certain amount of water for transpiration purposes. In other words, immediately after being gathered it is on the way to breaking down of its tissues and to decay. If it is fully ripe, it is much nearer a state of decay than if less ripe. Cold storage, therefore, reduces the activities of the fruit by holding it at a temperature at which it cannot function so rapidly, and checks the development of some diseases; but while it checks certain diseases it may pave the way for others to operate. Cold storage cannot make poor fruits over into good ones—it merely delays the day at which the fruit will become entirely decayed.

Why cold storage is vitally important. Under the present system it is impossible for most people to live near to where their food is produced. The food of a city like New York is brought from all parts of the earth and it is believed that 95 per cent of the total consumption is handled by rail or ship and in 1921 out of a total equivalent to 141,000 carlots of fruits and vegetables unloaded over 70 per cent moved by rail. Naturally, with commodities harvested but once a year, storage becomes extremely vital.

Today apples are on sale every month of the year. Frequently they are held in storage six to eight months. Oranges, lemons and grapefruits are on sale every month of the year. Strawberries are an illustration of a crop which is not held long in storage, but since this crop is grown over a large area, fresh supplies are available daily. Rapid transportation may involve a certain amount of cold storage in transit—precooling and shipment under ice. Practically all the California fruits and those from the Northwestern states have a rail journey of at least ten days, and in many cases longer. Even such commodities as potatoes, especially early potatoes from Colorado, are cooled and shipped under ice, although the main crops of potatoes consumed during the winter are held in common storage and are shipped in cars which merely protect from frost, or in which heaters are placed to maintain the temperature of the car above freezing. Apples and pears also move under heat.

Cold storage involves the maintenance of a proper temperature, and suitable humidity and ventilation. Not only must the temperature be kept low enough, but it must not be allowed to go so low that freezing takes place. Usually the latter is overcome by constructing the building so that cold cannot penetrate the walls, while the heat is removed by means of mechanical refrigeration, or the passing of cold blasts of air through the rooms containing the fruit. The holding of fruits by means of cold storage has been practiced by the Chinese for centuries, although mechanical cold storage plants are of recent development.

Storage temperatures. The temperature at which fruit is held has a very important effect upon its life because it tends to control its activity. The reduction in temperature reduces the activity of the fruit, hence it lengthens the life. In storage, we seek to reduce these activities to a minimum and yet not stop them entirely. If we stop them entirely, of course death follows. The right temperature at which a particular commodity should be held has given rise to much discussion. It has been found that fruits of the same kind, even *of the same variety*, may require different storage treatment, depending upon the place where the fruit was grown and how it was handled.

Probably handling is as important as any other factor. Improper handling may reduce the storage life of fruit 30 per cent or more. Apples grown in the middle coast section of California require a somewhat higher storage temperature than those grown in the mountains and other districts of the Pacific Coast. For instance, the varieties Yellow Newtown, Bellflower, Missouri Pippin, grown in this particular section must be held at a temperature not below 35° F., for if held at 32° F., a peculiar discoloration of the flesh results. Even when held under the best conditions, the Yellow Newtown apples grown in Central California keep one to three months less than the same variety grown in other portions of the Pacific Northwest and in Virginia. [Certain Jonathan and Rome Beauty seem to be susceptible to low temperatures and such should not be held below 32° F.] The apples which are grown on lighter loam soils are regarded by some storage men as more easily stored than those grown on very heavy, wet soils; but, generally speaking, apples produced on a heavy loam, especially if they show a slight lack of moisture, will have a longer storage life than those grown on a light loam where they have been allowed to reach full maturity or become of high color before harvest. The same thing is brought out in Tokay grapes grown in California. Those produced on light sandy soils reach their limit in regard to market condition by November, while those grown on heavy black soil will be in good condition until after Christmas.

Other factors affecting storage life. If an apple is gathered when immature (and the same is true of several other fruits) it is apt to shrivel in storage and it does not have good storage quality. The Emperor grape, an important storage fruit in California, if grown on a soil on which it does not color, does not have nearly as good storage qualities as when produced on red soils in the bench lands of the foothills of the Sierras. Fruits from young trees which are large, coarse and sappy, cannot be held as long in storage as those grown on more mature trees. Fruits grown on dense trees, those in which the branches are too thick, are apt to be immature, and in the case of several varieties of apples will probably show "scald" much sooner than will properly matured fruits. Hence pruning may have an effect upon the storage life of the fruit. The same thing is seen in grapes. Some growers on the Pacific Coast prune the vines to admit sunlight in order to have fruits which will store better. Apples grown in an orchard where too much water was applied, especially if the application was made late in the season, will not have as long a storage life as apples grown with a more moderate amount of water. There is no reason, however, why an apple grown on irrigated land should not have just as long storage life as the same variety grown under conditions where the water was furnished by rain.

The season materially affects the quality of the fruit from a storage standpoint. Thus, in particularly wet seasons, the fruits may be so sappy as to deteriorate rapidly. When a season has been particularly variable, it will be found that only fruits from the well-cultivated and well-sprayed orchard and in which the trees have been maintained under the best conditions will store in the most satisfactory manner. If apples are frosted before harvest the storage life may be reduced, depending upon the degree of freezing. In some cases it may not be advisable even to hold them very long after picking. Such fruit may be low in vitality and readily attacked by molds.

Watch fruit carefully in storage. The grower will need to consider all the facts when placing fruits in storage. Wherever the conditions have been unfavorable at any time during the year, it will be necessary to keep close watch of the fruit so that it may not be held too long. Fruit of low vitality will deteriorate very rapidly once it has reached the point of breaking down. It should be withdrawn from storage in time to permit of distribution before it does break down.

To insure good keeping in storage. For best conditions of storage, apples should be allowed to reach a hard-ripe condition. The fruit should be of good color for the variety; the flesh should be hard; the seeds full grown and colored; the fruit should not be overripe and there should be no tendency to soften. It may not be wise to permit full color. No one factor can be considered alone. The grower must study his fruit and his orchard and pick the fruit at such time that the maximum of life is before it. Frequently it is best to make more than one picking. This is especially true with early ripening fruits. The fruits on the outer branches, those exposed to the full sunshine, usually ripen first. It is frequently wise to pick and store them separately so that they may be watched.

Cool fruit quickly. Fruit should be cooled promptly. If the fruits are to be shipped to storage and are intended for long keeping the cars should be iced. Whether this should be done or not will depend, of course, upon the weather. For instance, in New York, in certain years there may be a temperature of 92° F. in the shade while picking Rhode Island Greening apples. The temperature at night may be 72° F. as a minimum. In other years the maximum temperature may be 52° F. and down to 38° F. at night. It will thus be apparent that the apples in the latter case are cold. They may stand in barrels for a day or two before being placed in storage and little perceptible harm result; while in the former case, two or three days out of storage may reduce the life of the fruits from a month to six weeks. The grower must take all of these points into consideration. The same is true of peaches, plums, pears and much more of strawberries and raspberries.

The ideal system. When fruit is stored, the storage should be so near that the fruit may be cooled within two hours after it leaves the tree. Motor trucks should be going continuously from the orchard to the storage. It may be more important in hot weather to run the fruit into storage and cool it than attempt to pack it, if it is for long keeping. Of course, if it is going directly to the market, or if the storage period is to be short a rehandling under such conditions is undesirable. The delay in placing in storage may be compensated by the reduction in cost of handling.

Necessity for care in handling. Fruit roughly handled in picking or packing, causing it to be bruised or the skin punctured by finger-nails, or pinched in the hands of the picker, has a much shorter storage life than fruit not so injured. A break in the skin allows the entrance of the blue mold fungus, which seldom attacks a fruit with a sound skin. This blue mold formerly was a most serious trouble with citrus fruits. Greater care in handling has greatly reduced the trouble.

Storage diseases. In certain seasons, bitter rot causes considerable trouble to apples in storage. This disease develops rapidly, especially when the apples are somewhat overgrown; or when the season has been wet just prior to harvest. Stippen or Baldwin spot develops more rapidly in seasons when the water supply is unequal or the trees fail to function properly. In other cases scab paves the way for the entrance of the pink-rot, which may cause considerable wastage of the fruit in barrels. In peaches and plums, brown rot may work havoc while the fruits are in storage. Some of the cankers which attack fruit trees affect the fruit and may lead to a rapid breakdown of the tissues in storage. Hence, the man who gives the orchard good care and keeps these diseases under control may be adding considerably to the life of the fruits.

Scald. Certain varieties of apples, such as York Imperial, Wagener, Rhode Island Greening, Rome Beauty and Stayman often show a marked tendency to turn brownish-skinned after being left in storage beyond a certain point. This brownish discoloration of the skin is due to the death of the cells. Scald is the dead skin of the apple, the cells of which were killed by products given off by the apples. Frequently, fruit will appear perfectly sound in storage but will turn brownish on exposure to the air after twenty-four hours or more. Before the retailer can sell to the consumer it apparently is unmerchantable, or must be sold at a sacrifice. Varieties that have an oily skin are less subject to scald. Wrapping apples in oiled paper* containing not less than 15 per cent of neutral oil or fat will reduce it. Varieties subject to scald should be held where there is a considerable movement of air. In other words, there is something given off by the apple which causes the death of the cells in the skin. and a movement of air in the storage will assist in avoiding the trouble. The oil in the skin of certain varieties absorbs this injurious substance or neutralizes it, thus preserving the apple. For the present, it looks as though such varieties should be stored where the air can be given a certain amount of movement or in storages where a forced draft ventilation system is in use. Storing near the alleyways instead of in the center of the pile is shown to be all that is necessary in some cases. It is also important that the fruits of these varieties be allowed to mature before harvesting, for immature fruits are more apt to show scald. The author has seen the best results with Rhode Island Greening when stored in slatted wooden crates and in the center of the room, not in a corner. The fruit was able to cool rapidly and it was benefited by any movement of the air caused by the opening of the doors. When properly harvested the loss was reduced to a minimum.

Scald is usually less severe if the fruit is held at 31 or 32° F. than if held at a higher temperature. To reduce the fruit to this point it is frequently advisable to lower the temperature to 25 to 27° F. as soon as the fruit is put in storage. Prompt cooling and a uniform temperature of about 31 or 32° F. after cooling has a marked influence in keeping the fruit.

Brown Heart is seen in Australian apples in England. It is a storage disease, caused by the excess of carbon dioxide in the air which causes death. It is most common when the fruit is loaded with the field heat in it, and the temperature remains high in transit and when the content of carbon-dioxide in the air in the holds is high and no ventilation is possible. The remedy is to precool the fruit, maintain a low temperature and ventilate at intervals. It is worthy of note that apples may be stored in an atmosphere of carbon-dioxide, when sufficient is present to depress respiration and other activities to a minimum, but they rapidly turn brown when withdrawn.

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*Distributing 1½ pounds shredded or ribbon oiled paper among the apples in a barrel materially reduces scald.

Storage life of summer, fall and winter apples. For commercial and storage purposes, apples go into three groups: Summer, fall and winter. Summer varieties have a short storage life. They may be held over for a week to avoid a glut in the market, but long storage of such varieties is not advised; they have their season and they will make more money if sold in season than if held. People do not want to buy Yellow Transparent when McIntosh are available. Fall apples have a longer season than the summer apples, but less than winter varieties. They may be carried up to Christmas. A variety such as Roxbury Russet, is not expected to appear on the market until March. Others, such as Rhode Island Greening, are generally off the market by that time. Varieties such as Stayman and York Imperial are off the market by March, while Winesap may be expected to share with Ben Davis, Gano and Yellow Newtown from March on to the end of the season, perhaps July.

Chemical changes during storage. Apples kept in cold storage at 32° F. show a slow loss of total solids, of carbohydrates, sucrose and acid. There is a slow increase of invert sugar. The evolution of carbon dioxide takes place slowly. In common storage, identical changes take place but they take place more rapidly. At summer temperatures of 65 to 70° F. these changes due to respiratory metabolism take place six to eight times as rapidly as in cold storage, while at 80° F. they take place sixteen to eighteen times as rapidly as at 32° F.

Loss in storage. Ben Davis apples were stored at 32°F. for 162 days, from October 20, 1901 to March 31, 1902. The total solids in the apple in October were 15.40 per cent, on March 31, 14.09 per cent; 1.31 loss, or 8.5 per cent of the total. The loss when stored at 70° F. for 161 days storage: total solids when stored 15.40 per cent; total solids in March, 12.58 per cent; a loss of 2.82 or 18.3 per cent of original. The loss is mainly in acids and carbohydrates. The acids decreased gradually in both cases, and more slowly at 32° F. The formation of invert sugar was less than half as fast when held at 32°F. as when held at 70° F. The volume of carbon dioxide evolved is a fair measure of the respiratory activity and of the loss of solids.

The temperature determines the rate at which fruit softens and its aroma. Such varieties as Jonathan, Delicious and Rome soften more in two weeks at a temperature of 60° F. than they will in four months at 30 to 32° F. Other varieties as Winesap, York, Ben Davis and Newtown soften more slowly, but a temperature of 50 to 60° F. maintained for a month will soften the fruit more than five or six months at 30° F. The acidity of the apple is also better maintained at the lower temperature. Fruit ripened on the tree or held at a temperature of 60 to 70° F. until soft ripe will develop the strongest possible aroma. Fruit held in cold storage long enough loses all ability to develop aroma. Winesap apples held at 30° F. for two months and then held at 60° F. until soft ripe will develop almost as much aroma as if never placed in storage; after 6 or 8 months storage less aroma will develop, but the maximum obtainable may be secured by softening the fruit at 60 to 70° F.

Storage of pears. Bartlett pears are often held in cold storage by canners until December. The fruit frequently loses much of its flavor by that time, and is not suitable for sale as fresh fruit. Bosc will be in season from Thanksgiving to Christmas. Easter Beurré, Clairgeau and Kieffer may be on the market until March. The keeping qualities of pears vary markedly with the conditions under which they are grown and handled. Pears grown in a warm climate, as southern California, keep better than those grown farther north. It is more important that pears be put in storage quickly than apples, because their life activities seem to be carried on at a more rapid rate but not so active perhaps as berries, peaches and some of the grapes. The bulk of the fruits of the temperate regions is held at 32° F.

Storage of citrus. Citrus fruits will not tolerate as low a temperature as apples. The United States Department of Agriculture's investigations indicate that temperatures below 45° F., if long continued, are detrimental to citrus fruits. A low temperature affects the skin and leads to the development of various storage diseases. Temperatures of 45 to 50° F. are thought to be best. Lemons are sometimes held from four to six months in common storage, without deterioration, provided proper attention be given to maintaining humidity. Too much ventilation is undesirable for citrus fruits.

Freezing fruits. The freezing of fruits has been proven economical where large quantities are used, as by pie and jam makers. This method has proven particularly desirable for sour cherries and raspberries but is not so satisfactory for strawberries. The fruit is placed at a temperature of 6 degrees below zero and frozen hard. When withdrawn the hard, frozen fruits are placed immediately between the piecrusts and the pies put in the oven. When handled in this way the results are quite satisfactory.

Storing fruit with sugar in barrels. Such fruits as raspberries, strawberries and cherries, when used for fruit juices and ice cream, are held in storage in barrels. The fruit is preserved with sugar, in some cases 1 pound of sugar to 2 or 3 pounds of fruit being used. In other cases pound for pound is used. This makes a quick way of putting the fruit where it can be readily held and transported. The containers are not expensive.

Cost of handling a barrel of apples. In 1919 the labor cost of handling a barrel of apples either into or out of storage in Boston varied from 5 to 7 cents with wages at 45 cents an hour. In Buffalo the labor cost was 6¼ cents with wages 50 cents an hour. Therefore, the total cost of handling in and out was 12½ cents plus 16 2-3 cents for overhead and plus 10 per cent profit, which is practically 32 cents. The actual cost of handling in Boston varied from 25 to 40 cents a barrel. The labor cost of handling is one of the chief items of operating expense in storage.

Some operating costs. The actual cost of operating a cold storage plant in Western New York in 1909, including handling, was 6.65 cents per cubic foot of space. In 1919 it was 10.5 cents per cubic foot of space. Coal and labor had advanced 250 per cent, machinery and repairs 300 to 400 per cent on some articles. This storage handled carlot movements in the main. The costs of a general storage might be higher. A barrel of apples occupies 8½ cubic feet of space. If held for six months we have the following:

1909: 8½ cubic feet, costing 6.65 cents per cubic foot or 56.52 cents a year. For six months' storage this was 28.26 cents a barrel.
1919: 8½ cubic feet, costing 10.5 cents per cubic foot or 89.25 cents a year. For six months' storage this was 44.62 cents a barrel.

If the storage plant is unoccupied during the other six months there is still left the overhead—interest, depreciation on buildings, machinery, taxes, etc. This was 15.7 cents for six months or about 35 per cent of the total cost. Hence, the cost for storing a barrel under such conditions would be 60.32 cents a barrel. Storage, however, was obtainable at 50 cents a barrel. It is readily seen why farmers and fruit growers' organizations shipped their fruit to a central point for storage or built their storages at rail points where these could be used throughout the year and for other commodities such as butter, beef, eggs, etc., when not required for fruit.

Charges not always based on cost. If storage rooms are to be profitably operated they must be kept full and the stored commodity must rest undisturbed for long periods of time. The costs incidental to the removal of small lots, the opening and closing of the rooms, the labor incidental to handling for short intervals have not been adequately considered in determining cold storage charges.

The effect of volume on storage costs. In 1919 a room in one of the Western New York storage houses was filled with 9,500 barrels of apples at a storage charge of 50 cents each for the season. This insured a revenue of $4,750. The cost of all operations for six months was $4,354, leaving a net return of $396. The room was closed except for the four days it took to fill and nine days to empty. To insure a profit it was necessary to refill the room with another commodity for the remaining period of the year, otherwise the apparent gain would be consumed by the overhead of the ensuing six months.

Storage rates are predicated on the labor involved in handling in and out of storage; the total weight per cubic foot of space occupied and the amount of initial and holding refrigeration required. Charges are based on the contents and the package, since the package must be cooled and kept cold the same as its contents. The same principle is used in fixing the charges for transportation.

Cold storage legislation. Considerable agitation has been directed against cold storage food. Most of this is based on ignorance and hysteria. Cold storage is a necessity. There is no occasion to limit the time that fruits and vegetables may be allowed to remain in storage. The purchaser of these products can see whether they are sound or decayed.

Common storage. In Nova Scotia are seen conditions under which the common storage of apples is commercial. It should be recognized that the Nova Scotia shippers aim to have most of their fruit in transit by January. They do not attempt later keeping than March. There are about 130 frost-proof storages varying in size from 40x80 to 50x175 feet. A storage 40x100 feet has a capacity of 10,000 barrels. The prewar cost was about $10,000. In the United States there is no marked tendency to increase the amount of space used for common storage of apples, except as a measure of temporary relief. A great many growers are equipped with common storage, but fruit so held must usually be moved by January. Owing to the frequent inability to secure low temperatures in such storages, during the fall when the fruit is going into storage, the growers are recognizing that it is safer to put the fruits in cold storage where the temperatures can be rigidly maintained. The great benefit of cold storage is that the fruit can be promptly cooled and the great handicap of common storage is that it provides no means for so doing. Even with ventilation shafts and flues, the fruit cannot be carried as long as is frequently necessary or with the certainty essential in business.

Citrus fruits lend themelves very well to common storage. Low temperatures are not required. It is recognized that the humidity content should be very carefully watched to prevent shrinkage from evaporation. A relative humidity of about 80 to 85 per cent at a temperature of 50° F. has been found to be most satisfactory under conditions existing in California lemon storage houses. This must not be taken too arbitrarily, but it is an approximation. It represents a relatively high humidity. The point to note is that if the temperature of the air rises without the addition of moisture, its capacity for absorbing moisture will be exercised and it will take it from the fruit. The reverse of this is seen when fruit is withdrawn from cold storage and brought into a warm atmosphere. The cold fruit chills the air in the immediate vicinity and the moisture is deposited from the air upon the fruit, thus causing it to "sweat."

To avoid "sweating" in transit. When moving fruits from cold storage to market it is common to put one or two tons of ice in the refrigerator car just to maintain the temperature until the fruit reaches destination. When the car is opened the fruit will appear dry, whereas if shipped in box cars in which the air can circulate a considerable amount of moisture is deposited on the fruit. If the temperature of the fruit is gradually raised the fruit may be brought up to outside air temperatures without this sweating. It is claimed that fruits have a longer life if the temperature be allowed to rise gradually when they are withdrawn from cold storage than is the case when the temperature is rapidly increased.

Effect of cold storage on exports. The possibilities of cold storage in extending the shipping season of peaches, plums, pears and other fruits is recognized. Its effect upon apples is seen in the export figures. Cold storage has extended the time during which apple exports are made. In 1893 to 1896, the four years just preceding the rapid development of cold storage, 78,907 barrels of apples were exported between January 1 and June 1, or 17.9 per cent of the exports for the fiscal year. During the next few years, 1897 to 1903, a period when cold storages were being rapidly built in the United States, 240,688 barrels per year were exported between January 1 and June 1, or 25.9 per cent of the total exports, a gain of 8 per cent. Taking the period of 1911 to 1913 (three years), and the same months, January 1 to the end of the shipping season, the exports were 2,235,955 barrels out of a total of 7,504,961 shipped or 29.8 per cent, showing a further gain. In the season 1919 to 1920 it was 33.4 per cent of the total. Taking the period March 1 to June 1, for the years 1893 to 1896, but 4.5 per cent of the exports was made in these months; in the years 1897 to 1903 the exports were 8.03 per cent, and in the same period in the years 1911 to 1913 they were 9.4 per cent of the season's total. Cold storage not only enables the fruitgrower to avoid loss but it greatly extends the season of marketing. The export figures would undoubtedly show a larger gain, but for the competition of Australian apples which begin to arrive in Europe in March or April.

From 1899 to 1919 our population increased about 40 per cent, but the cold storage holding of apples increased over 300 per cent in the two decades. The increase in cold storage space together with the increase in the commercial production of apples has made it possible to have apples in every month of the year. From June to October the new crop moves into consumption direct from the orchard, and from October to January or sometimes later there is a movement from farmers' barns, cellars and common storage as well as the cold storage movement.

Rate of movement of apples from cold storage. The rate at which the crop moves from cold storage may be approximated from the figures given above. The rate of movement from 437 cold storages in 1915-16 as reported by the United States Bureau of Markets was approximately: December, 12 per cent; January, 15 per cent; February, 20 per cent; March, 20 per cent; April, 16.5 per cent; in storage May 1, 16.5 per cent.

COLD STORAGE HOLDINGS OF APPLES

(*Barrels with boxes combined in terms of barrels*).

UNITED STATES DEPARTMENT OF AGRICULTURE

Date	1915	1916	1917	1918
January	4,293,225	4,812,889	4,132,157	4,598,524
February	3,584,688	4,236,453	3,384,706	3,956,949
March	2,490,920	3,241,845	2,442,051	2,829,912
April	1,343,117	1,983,609	1,545,105	1,783,095
May	474,213	1,034,925	807,825	677,587
June	108,212	303,534	265,295	158,830
October				
November	3,688,981	3,259,739	3,296,259	3,752,342
December	5,441,389	4,492,043	4,689,290	4,928,311

Date	1919	1920	1921	1922
January	4,294,191	5,528,754	6,385,607	5,428,711
February	3,105,215	4,523,894	5,104,655	4,313,157
March	1,771,907	3,161,638	3,649,541	3,090,018
April	956,459	1,698,603	2,209,525	1,929,675
May	379,713	806,460	1,118,699	944,290
June	124,764	213,370	445,476	313,907
October	971,057	543,977	792,032	
November	4,522,994	4,474,971	3,643,102	
December	5,923,079	6,786,913	5,739,395	

The above figures are only partially complete. They show the quantity stored in certain warehouses. They cannot be taken as indicating the total quantity stored nor do they show the portion of the crop which was stored in the different years.

RATE OF MOVEMENT OF APPLES FROM COLD STORAGE

	Number of firms reporting	Barrels	Boxes	Combined holdings expressed in barrels†	Comparison of holdings on a percentage Basis
Dec. 1, 1915	437	4,792,855	3,900,335	6,092,967	100.0
Jan. 1, 1916	437	4,208,445	3,453,069	5,359,468	88.0
Feb. 1, 1916	437	3,527,639	2,819,941	4,467,619	73.3
Mar. 1, 1916	437	2,575,653	1,993,967	3,240,309	53.2
Apr. 1, 1916	437	1,594,447	1,287,118	2,023,486	33.2
May 1, 1916	437	765,649	718,709	1,005,219	16.5

†Boxes taken as three boxes equal to one barrel and combined with barrels.

CHAPTER XXV

TRANSPORTATION

In discussing transportation we no longer measure distance in miles but rather in cost. The cost of the service is the commercial measure of distance. The United States Department of Agriculture estimated that the cost of transporting a ton of freight a mile over our ordinary roads, under pre-war conditions, was about 25 cents. In 1921 it could be hauled in carlot quantities on the average American railroad, taking all commodities for about 1.27 cents; under pre-war conditions, from 1910 to 1914, the cost was 0.744 cents, or 135 miles for $1. In 1913 the average freight rate on the Great Lakes through the "Soo" was two-thirds of a mill per ton, or 1,500 miles for $1. This brings out the fact that water transportation is the cheapest and that every increase in freight rates, unless accompanied by a sufficient increase in the price received for the commodity, restricts the area of distribution.

Freight charges and returns. A survey embracing 9,476 cars of fresh fruits and vegetables shipped and distributed between September, 1920, and July, 1921, showed that freight charges, including all factors, were $3,448,339, or 32.79 per cent of the wholesale sales price, or an average of $364 per car. The freight and express charges exclusive of transportation tax and including all other factors were $3,342,469, or 31.79 per cent of the total sales, or an average of $352 per car. Transportation tax amounted to $105,869. The total sales amounted to $10,514,508, or an average of $1,109 per car. Miscellaneous handling costs—storage, cartage, unloading costs, reconditioning of goods on arrival, repacking, recoopering, loading costs, government inspection, weighing, containers and other miscellaneous costs of handling totalled $466,977 or 4.43 per cent of the sales price, or an average of $49.28 per car.

The wholesaler's gross profit on purchased and consigned cars was $332,789 or 3.16 per cent of the sales price or an average of $35.13 per car. The wholesaler's operating cost, or cost of doing business, was $557,941 or 5.3 per cent of the sales price, or an average of $58.87 per car. The wholesaler's total loss on purchased and consigned goods taken together was $252,241, or 2.39 per cent of the sales price or an average of $26.61 per car, and this does not include interest on capital or salaries of executive officers.

The shipper (in some cases this was the grower) received $6,271,135 or 59.62 per cent of the sales price, or an average of $661.79 per car. The carriers, excluding transportation tax, received an amount equal to 53.3 per cent of what the shippers received.

Freight paid on certain specific fruits. The total sales price on 77,212 cars of which the 9,476 cars above were a part, was $147,847,171. The freight paid, including transportation tax, was $51,690,184 or 34.96 per cent of the wholesale sales price. The transportation tax was $1,505,539, or 1.02 per cent of the sales price, so that the freight, less transportation tax, was $50,184,645, or 33.94 per cent of the wholesale sales price. (''Wholesale Distribution of Fresh Fruits and Vegetables, Phillips and Fraser.'')

In the case of 2,022 cars of barrel apples handled between September, 1920, and June, 1921, with hauls varying from 200 to 600 miles and an average of about 400 miles, the freight charges amounted to an average of $95.49 per car or 12 per cent of the wholesale sales price. In 1,466 cars of box apples, with an average haul of 2,800 miles, the freight charges averaged $697.36 per car, or 36.23 per cent of the wholesale sales price; in 204 cars Florida citrus, average haul, 1,200 to 1,300 miles, freight charges averaged $452.66 per car, or 26.64 per cent of the wholesale sales price; in 140 cars California grapes, average haul, 2,300 miles, freight charges averaged $655.79 per car, or 28.11 per cent of the wholesale sales price; in 83 cars, New York and Michigan grapes, average haul, 300 miles, freight charges averaged $215.07, or 12.4 per cent of the wholesale sales price; in 48 cars, Idaho prunes with an average haul of 1,325 miles, freight charges averaged $578.47 per car, or 41.52 per cent of the wholesale sales price. Generally speaking, freight charges constitute about one-third of the wholesale sales price of these commodities, and the grower so located that he has a low freight rate to market, has an advantage.

American railroads have not furnished any evidence to show that they know the real cost of transporting any given commodity nor do they keep their records to show the revenue derived from specific commodities. They are in the condition of a farmer who knows his total income and total outgo and the balance is either a profit or a loss. How it was secured, which commodity made or lost money, is not known. Data secured by

Phillips and Fraser show that while fresh fruits and vegetables constitute but 1.34 per cent of the tonnage originated by rail carriers they furnished about 8 per cent of the freight revenue, and growers and shippers contend that these commodities are bearing too heavy a burden.

Transportation is a basic element in the development of agriculture, manufactures and commerce. It is peculiarly vital to the fruitgrower because the volume of produce from an acre is large. Thus an acre of citrus may produce a carload, but an acre of cotton may produce but a bale. An acre of good grassland will produce 100 pounds of beef when grazed by a steer, but an acre of apples, peaches, strawberries, small fruits will furnish half a carload. The relation of the transportation costs to other cost factors fixing prices, especially where the margins of profit are small as they are in agriculture, may mean the life of the industry. Generally speaking, freight rates are made on the principle of "what the traffic will bear." For instance, all western fruits move on what are known as "commodity rates," which have been made upon the basis of what the commodity can pay. California fruit may be hauled 2,500 miles for the same price per ton that Texas or Florida fruit is hauled 1,500 miles. The rate is not based on mileage hauled. The Western New York shipper of apples pays more per ton-mile for hauling his fruit than does the shipper from the Pacific Coast. He does not pay as much per ton because the distance which his fruit is shipped is usually much less. Western box apples are shipped an average distance of from 2,500 to 2,800 miles, while New York apples are shipped an average of about 500 miles. California oranges are hauled on an average 2,500 miles, while the length of haul of Florida oranges is 1,200 to 1,300 miles.

Official classification territory. The northeastern portion of the United States—east of Chicago and north of the Ohio River and to about Richmond, Va.—is known to railroad men as Official Classification Territory. In this region fruits and vegetables are shipped, generally under class rates, while outside of this area they move on commodity rates. Class rates are generally based on distance hauled and, in connection with the standard classification, are basic. The tariff contains six classes with, in some instances, rates between two classes. Until recently peaches, for instance, moved on first class. They are at present in the second class, while apples and pears take fifth class. There is a 15 per cent difference in the rate between classes, second being 15 per cent less than first. Bricks, gravel and such commodities take the lowest rate.

In official classification territory there is no absolute uniformity in regard to the rate for the same class. There are in fact over fifty different bases for determining the rate. The first-class rate on one road for a 400-mile haul may be above or below the first-class rate on another road for a different 400-mile haul. The Interstate Commerce Commission is now attempting to establish some uniformity in these rates. In some instances this may lead to actual increases in the freight charge.

The importance of commodity rates to the fruit and vegetable industry is perhaps better illustrated by an example. During 1920-21, peaches moving from Fresno, California, to New York, paid a freight of $1.91 per 100 pounds, and there is a movement on this basis. To ship peaches from New York to Fresno, however, would involve the payment of the first-class rate throughout, or $6.16½ per 100 pounds. There is no movement of peaches in this direction, but since, in commodity rates, mileage has ceased to be more than a minor factor, it follows that if there was a possibility of establishing a trade for New York peaches in California, the growers of New York would be justified in asking for commodity rates based on ''what the commodity could bear.'' The importance of commodity rates is shown by the above, for while California paid $1.91 per 100 pounds for a haul of about 3,000 miles, the New York peach shipper paid 71 cents per 100 pounds for a haul of 400 miles, viz., Rochester to New York, and the California peach grower enjoyed a rate of 49 cents per 100 pounds for a 400-mile haul in California. In 1921 the peach shippers of the East were able to convince the railroads that 71 cents per 100 pounds was too much for a 400-mile haul, with the result that peaches were reduced from first to second class, and it is the contention of shippers that peaches should be placed in third class. This illustration will show the value of commodity rates in developing the movement of fruits and vegetables from the South and West. Over half the fruits and vegetables transported by rail are moved east from points west of the Mississippi River. Commodity rates have made possible the production of fruits and vegetables at western and southern points, even though transportation charges are frequently equal to and sometimes greatly exceed the amount the producer receives for the commodity free on board the car.

The tonnage and percentage of fresh and dried fruits and vegetables, also canned food products originated by Class 1 roads, east and west of the Mississippi River as reported to the Interstate Commerce Commission is shown in the table on page 288:

Commodity	East of Mississippi		West of Mississippi		Total United States		Percent of Tonnage	
	Cars	Tons	Cars	Tons	Cars	Tons	East of Miss.	West of Miss.
YEAR 1920								
Citrus	45,357	704,450	40,064	720,059	85,421	1,424,509	49.45	50.55
Other fresh fruits	202,984	2,958,377	152,410	2,293,038	355,394	5,251,415	56.33	43.67
Potatoes	122,682	2,353,211	96,531	1,763,371	219,213	4,116,582	57.16	42.84
Other fresh vegetables	94,185	1,309,581	60,174	904,099	154,359	2,213,680	59.16	40.84
Dried fruits and vegetables	21,204	446,805	23,777	718,889	44,981	1,165,694	38.33	61.67
Canned food products	65,274	1,484,393	59,037	1,596,198	124,311	3,080,591	48.19	51.81
TOTAL	551,686	9,256,817	431,993	7,995,654	983,679	17,252,471	53.73	46.27
Total fresh	465,208	7,325,619	349,179	5,680,567	814,387	13,006,186	56.41	43.59
Total dried and canned	86,478	1,931,198	82,814	2,315,087	169,292	4,246,285	45.48	54.52
YEAR 1921								
Citrus	40,372	585,199	52,610	922,532	92,982	1,507,731	38.81	61.19
Other fresh fruits	164,474	2,148,130	164,792	2,481,027	329,266	4,629,157	46.40	53.60
Potatoes	135,079	2,505,654	119,305	2,133,264	254,384	4,638,918	54.01	45.99
Other fresh vegetables	95,522	1,191,610	51,955	696,473	147,477	1,888,083	63.11	35.89
Dried fruits and vegetables	20,861	403,505	26,117	775,438	46,978	1,178,934	34.23	65.77
Canned food products	61,145	1,300,394	52,411	1,325,281	113,556	2,625,675	49.53	50.47
TOTAL	517,453	8,134,492	467,190	8,334,015	984,643	16,468,498	49.39	50.61
Total fresh	435,447	6,430,593	388,662	6,233,296	824,109	12,663,889	50.78	49.22
Total dried and canned	82,006	1,703,899	78,528	2,100,719	160,534	3,804,609	44.78	55.21

The tonnage and percentage of total fruits and vegetables, fresh, dried and canned food products originated east and west of the Mississippi River by Class 1 roads is shown below:

Year	Eastern	Southern and Pocahontas	Western and Pacific	Percent East of Miss.	Percent West of Miss.
1918	6,581,387	2,160,322	9,995,710	46.65	53.35
1919	6,002,997	2,075,590	11,647,482	40.95	59.05
1920	6,701,038	2,555,779	7,995,654	53.73	46.27
1921	5,909,601	2,224,991	8,334,015	49.39	50.61

The amount of fresh fruits and vegetables, dried fruits and vegetables and canned food products originated and handled by rail carriers in the United States from 1889 to 1922 is shown in the table below:

FRUITS AND VEGETABLES ORIGINATED AND HANDLED BY RAIL CARRIERS

	Originated		Handled	
Year	Carloads	Tons	Carloads	Tons
1899 . . .		4,582,573		11,635,846
1900 . . .		5,213,210		13,106,026
1901 . . .		5,846,184		14,508,551
1902 . . .		6,295,028		14,501,968
1903 . . .		7,210,190		17,033,868
1904 . . .		7,833,914		18,832,436
1905 . . .		9,230,535		21,447,415
1906 . . .		8,921,262		20,502,423
1907 . . .		9,719,117		21,982,354
1908 . . .		9,516,962		22,136,182
1909 . . .		9,762,769		24,298,311
1910 . . .		11,339,921		27,968,788
1911 . . .		11,084,010		27,620,942
1912 . . .		12,130,061		29,696,291
1913 . . .		15,424,690		34,724,817
1914 . . .		16,034,696		37,986,613
1915 . . .		17,133,451		40,566,680
1916 . . .		17,408,553		40,221,655
1917 . . .		17,678,958		43,145,895
1918 . . .		18,737,419		44,674,265
1919 . . .		19,726,069		50,976,469
1920 . . .	983,679	17,252,471	2,725,030	48,328,796
1921 . . .	984,643	16,468,498	2,862,896	47,702,869
1922 . . .	1,064,024	17,619,104	3,075,516	50,195,086

(1) From 1899 to 1919 inclusive the figures include fresh fruits and vegetables, dried fruits and vegetables and canned fruits and vegetables. The figures for 1920 to 1922 include fresh fruits and vegetables, dried fruits and vegetables and all canned food products, whether fruits or vegetables or otherwise. Prior to 1920 fresh fruits and vegetables were not segregated in the Interstate Commerce Commission's Reports. Dried fruits and vegetables and canned food products have, therefore, been added to the fresh fruit and vegetable tonnage for 1920 to 1922 as a basis for comparison. All canned

food products have been used because, since 1920, the Commission's Reports do not segregate canned fruits and vegetables. In so far as all canned food products include other foods than fruits and vegetables, fish for example, the 1920 to 1922 figures show in excess of the actual tonnage of fresh, dried and canned fruits and vegetables actually originated and handled. The decrease in fruit and vegetable tonnage proper for the years 1920 to 1922 was, therefore, greater than the figures indicate

(2) Tonnage from 1899-10 inclusive covers all operating roads. Tonnage for 1911-22 inclusive covers Class I Roads, i.e., roads having annual operating revenue in excess of $1,000,000.

(3 Actual carloads are not available prior to 1920, the figures up to that time having been compiled on a tonnage basis only. Actual carloads for 1920 to 1922 have been taken from the carriers' quarterly reports to the Interstate Commerce Commission. The average per car on fresh and dried fruits and vegetables and all canned food products originated for 1920 was 17.53 tons; for 1921, 16.72 tons; average for both years 17.12 tons. The number of carloads per year prior to 1920 could be approximated by using the factor of 17.12 tons per car, but the result would not be accurate, due to variation in loading. Loading prior to the war was not as heavy as during the war, when, under the existing necessities, loading was abnormally heavy and in many cases in excess of safe carrying capacity. The average per car on fresh fruits and vegetables originated in 1920 was 15.97 tons, in 1921, 15.36 tons, in 1922, 15.1 tons.

(4) "Originated" means tonnage originated at point of origin and shows the inception of the movement. This is the true index of the amount of a crop or product actually moved from point of production. The column "Handled" includes movement over more than one line. For example, a carload of apples may "originate" on the Great Northern and pass thence to the Burlington, thence to the Erie. It would be reported as "Handled" by the two latter.

A statement showing percentage increase in tonnage of fresh fruits and vegetables, dried fruits and vegetables and canned food products originated by rail carriers, 1899 to 1922 inclusive, is given in the next table. This table is based on the tonnage figures under the column "Originated" in the preceding table. The year 1899 is taken as the base, or 100. Figures for subsequent years show the percentage relationship which such years bear to 1899.

INCREASE TONNAGE OF FRUITS AND VEGETABLES

Year	Percentage	Year	Percentage	Year	Percentage
1899	100	1907	212	1915	373
1900	115	1908	207	1916	379
1901	127	1909	213	1917	385
1902	137	1910	247	1918	408
1903	159	1911	241	1919	430
1904	171	1912	264	1920	376
1905	201	1913	336	1921	359
1906	194	1914	349	1922	384

A study of the two preceding tables shows the remarkable advances made by the fresh fruit and vegetable industry and its allied lines during these twenty-four years. It will be noted that between 1899 and 1905 the traffic doubled; that between 1905 and 1918 it again doubled, showing 408 per cent of 1899. In other words, the traffic more than quadrupled in twenty years. In 1919 it reached the peak of 430 per cent of 1899. In 1920 to

1922 there was a decrease, due primarily to deflation in farm commodities following the World War and business depression, coupled with inflation in transportation costs and other "fixed charges." The 1920 traffic showed a decrease from 1919 of 12.6 per cent; the 1921 decrease from 1919 was 16.6 per cent; the 1921 decrease from 1920 was 4.5 per cent; the 1922 traffic was 10.7 per cent below 1919.

Reasons for the increase in rail movement. The rapid congestion of population in cities, the prosperity which has come to the workers in industrial centers, the increase in the standard of living, the development of varieties of fruits and vegetables to meet commercial requirements, the improvement in methods of production, harvesting, packing and the development of the refrigerator car and of the transportation and distribution systems have all had a part in stimulating the increase in rail movement. The increase in the movement of these commodities is not confined to the United States. In Germany, with the rapid development in industry, in the decade prior to the war, there was a phenomenal increase. Fruits and vegetables are important sources of vitamines and are essential for the maintenance of our population on the present high standard of performance and health.

The important developments of these two decades are:

(a) A fourfold increase in the volume of the movement.

(b) The loading of cars is heavier.

(c) The haul is longer. Until recently none of our apples were hauled across the continent. Now half the commercial winter crop is moved over 2,000 miles. From 45,000 to 60,000 cars of citrus are moved from California, an average of 2,500 miles. The average Florida movement is 1,200 to 1,300 miles. Peaches from New York average about 430 miles and apples 550 miles, both short hauls. The average length of haul of fruits and vegetables in 1919-21 was about 1,500 miles. No nation shows a like rail movement.

(d) The development of centralized and specialized production in various parts of the country.

(e) The development of central packing establishments has much increased the carlot movement and reduced the less-carlot.

(f) The concentration of fruit in cold storages increases the time that rail equipment can be used for the movement of these commodities and the period of consumption.

(g) The carlot movement, as compared with the less-carlot, is greater.

(h) Marked improvement is seen in standardization, grading, packing and loading of the fruits.

Freight rates. It is important that shippers of fruit examine and understand their freight bills. Claims for refunds should be filed within four months from date of payment. The items which may appear in a freight bill are: The line haul charge usually spoken of as the freight; refrigeration, extra icing, heater charges; switching; storage in transit; diversion and reconsignment; storage, sorting and tally charges, and demurrage. There is a proper charge for each. Large shippers find it necessary to maintain a traffic department to look after their transportation interests. Tariffs showing the charges are required to be on file at the freight office and are open to inspection. It is important to understand how to bill out a car and to see that all notations are correctly made. Shippers for their own protection must keep posted in regard to tariff regulations.

In 1875 the railroad companies moved the refrigerator cars attached to the passenger trains. The rate from Chicago to New York on perishables up to that year was $2 per 100 pounds. Of course, the movement was limited. In 1884 the maximum movement on the Pennsylvania railroad from Chicago on any one day was but 77 tons. In 1875 rates were reduced to $1.50 per 100 pounds, and the rate from that time to the present on fast freight, without refrigeration, for the first three classes, is given below:

FREIGHT RATES—CHICAGO TO NEW YORK
ON FIRST, SECOND AND THIRD CLASS FREIGHT, 1875-1922.

Year	First class 100 pounds	Second class 100 pounds	Third class 100 pounds
1875	$1.50	$1.10	$0.85
1878	1.20	.90	.70
1881	1.00	.85	.70
1887 O. C.	.75	.65	.50
1915 5% Advance	.79	.685	.525
1917 15% "	.90	.79	.605
1918 25% "	1.125	.99	.75
*1920 40% "	1.575	1.385	1.05

*+3% Transportation Tax.

July 1, 1922, a general 10 per cent reduction was ordered by the Interstate Commerce Commission.

During part of the period 1887 to 1915 there was a first-class boat-and-rail rate of 68½ cents per 100 pounds.

The figures show that transportation costs in 1920 exceeded those in effect in 1875. A 100 percent advance over the rate in effect in 1887 was perhaps not out of line with the general advance in all commodities in 1919, but with the deflation in farm commodity prices in 1920 such increases became a serious burden upon these products and will, if continued, lead to a readjustment in agriculture in many regions. Today the rates charged for refrigeration are fixed. The charge is based on the cost of the service plus a profit. Formerly the basis was to "get what the traffic would bear," but in Interstate Commerce Commission case 10,664, p. 458, the Director-General of Railroads advice in regard to rates for refrigeration of perishables reads: "It was further directed in formulating such schedules, to proceed on the principle that *a carrier is entitled for any service rendered to compensation based on cost plus a reasonable profit.*" Ten per cent was regarded as reasonable. Under this policy the more inefficient the service and the more costly it is, the greater the profit.

In 1921, 50.7 per cent of the total revenue of railroads was used for the payment of employees; in 1910, 40.67 per cent was so used. In 1921, the average yearly wage per man on the railroads was $1,686; in 1917 it was $1,003, or an increase of 81.3 per cent in 1921 over 1917. The average annual wage of employees engaged in manufactures in the United States in 1920 was $1,100. Labor on railroads as well as in other lines has decided to oppose any tendency to deflate wages. So long as this policy can be maintained the costs of transportation and the other services performed in distribution will necessarily remain high and will react upon production of our food supplies.

Blanket rate. Freight rates apply from one zone to another. In the case of western movements the freight rate may be the same to Chicago and all points east thereof. The charge is no more to move the car to Jacksonville, Florida, or Boston, Massachusetts, than to Chicago. This is done to aid distribution and the territory so covered is known as "blanket rate" territory.

Classification. The class under which a commodity is listed in the tariff is determined by a classification committee of the railroads. This committee grants hearings to those interested and issues findings. An appeal may be made by taking the case to the Interstate Commerce Commission.

The classification is reduced by: (a) Greater loading; (b) increasing the average length of haul; (c) reduction in loss and damage claims; (d) increasing the carlot movement, as compared with the less-carlot movement; (e) greater volume (if train loads can be moved we are entitled to a lesser rate), and (f) more efficient packing.

The classification is increased when: (a) There is increase in liability on the part of the railroad; (b) the original rating has been too low; (c) expedited service is required and secured, and (d) special equipment is furnished.

Equipment. The financial success of the fruitgrower depends upon the ability of the railroad to move his crop to market. When the railroads are unable to furnish equipment, as was the case in 1922 and many times prior thereto, notably in 1906, 1916 and 1920, growers and shippers are injured.

Refrigerator cars. In 1921 there were 118,738 refrigerator cars; 21,500 of these were packers' cars, fitted for meats and dairy products. Deducting other special service cars and those in bad order, there were available for the movement of fruits and vegetables between 80,000 and 82,000 cars. The above includes the railroad-owned and private cars. In 1902 there were 72,744 refrigerator cars so that 1921 shows an increase of 63 per cent in two decades, while the actual volume of goods moved was over two and one-half times greater. During the period from 1920 to 1924 about 52,667 new, well-designed and well-insulated refrigerator cars were ordered or built, bringing the total number available for the movement of fruits and vegetables to about 110,000 cars. This commendable activity should be continued until all the old equipment is retired or rebuilt to meet United States standard specifications.

The United States Department of Agriculture in 1918 outlined what should be considered a standard refrigerator car, and the United States Railroad Administration accepted it. In 1922 both the Agricultural Conference at Washington and the Joint Commission of Agricultural Inquiry approved, adopted or recommended this same standard car. Briefly, the insulation in such a car should be at least 2½ inches of cork or its equivalent in the roof, provided the insulation is not broken, or 3 inches if it is; and 2 inches of cork or its equivalent in the walls, ends and floor, provided the insulation is not broken. The specifications call for a floor rack raised 4 inches from the floor, wire basket bunkers, with a capacity of five tons of ice and insulated bulk heads. Much of the equipment now in use falls below this standard of insulation; over 36,000 cars have but 1 inch or less, and as recently as 1919 but 11 per cent of the total equipment had 2 inches of insulation or over. Cars inadequately insulated are unable to refrigerate their load; the temperature of the load fluctuates with that of the outside air, and in winter it is not possible to protect the commodity from frost. If faulty, poorly insulated equipment fails to carry its load there is just ground for a claim. The carrier undertakes to perform a service which he fails to do.

The bunkers. The present charges for refrigeration are based on the use of cars capable of holding 5 tons of ice in the bunkers. Many cars have a bunker capacity below this figure, some holding but 1½ to 3 tons. This amount is inadequate in the case of many fruits. The charge for the refrigeration service is the same whether a modern efficient car is furnished or an antiquated and practically worthless car is used. The modern cars are equipped with a wire-basket bunker, which holds the ice away from the sides of the car and permits the air to circulate on all sides of the ice, while in the old box bunker type the ice lies in contact with the outside walls of the car and the air has to pass through the ice so that circulation is slow and the loss of ice from cooling the outside walls of the car is considerable. The bulkhead, which separates the ice from the load, should be insulated. This permits the use of salt with the ice to cool the load; if not insulated, and almost all of the older cars are not, salt cannot be used with the ice because of danger of freezing the load.

Floor racks. It is essential that there be a circulation of air on the floor of the refrigerator car to secure proper refrigeration of the load. For the money expended there is no one improvement which gives as large returns as placing floor racks in the cars. They tend to prevent freezing of the load in cold weather and aid refrigeration in hot weather. The floor rack should be 4 inches from the floor and in loading care should be taken to see that the floor opening into the ice bunker chamber is not blocked. If highly perishable commodities are to be shipped in hot weather and no floor racks are in the car they should be built according to standard specifications and a specified sum for same may be secured from the railroad.

Suggestions in ordering and loading a car. The railroad tariffs outline the proper procedure to follow in ordering a car. The order should be in writing, stating the type of car required, destination if possible, the commodity to be loaded, and in the case of a refrigerator car whether it is to be dry or iced, shipped under standard or half-tank refrigeration or under Rule 240, heater or option No. 1 or No. 2. Under normal conditions forty-eight hours are considered a reasonable notice. On receipt of the car the shipper should inspect and make note of its condition, whether there are any holes in the floor, the doors fit tight, the plugs are in place, the amount of ice, and it should be poled to make sure that it has not bridged. These notations should be recorded and may be filed with the freight agent when billing out the car. Keep a record of the date when ordered, hour and date received for loading, when loaded and the hour of filing the bill of lading. With such data one may frequently succeed in establishing a claim which would be impossible without such record. If cars are sold on commission the receiver should be asked to make a similar report as to condition on arrival.

The space between the doors is the most difficult part of the car to refrigerate and is, therefore, frequently left vacant. This aids refrigeration. Under such conditions the load may be squeezed into place and braced to make sure it will not shift. In loading boxes on a floor rack it is necessary to put the bottom tier on strips, running lengthwise of the car to facilitate the squeezing. When loading the car in the winter, the floor, walls and ends are covered with building paper, and the floor may be covered with straw or shavings. The car is heated before loading. The doors also are covered with paper on the outside and the load is packed as tightly as possible. In cold weather the floor and doors are the critical parts of the car.

Billing out the car. In making out the bill of lading state the exact number of packages of each commodity by size or weight, and the total weight. Such a billing may be marked S. L. & T. (shipper's load and tally). This does not in any way affect the liability of the railroad for loss in transit, but it may be necessary in case of loss that the shipper have proof that the tally was correct. If the car is shipped under ventilation it may be billed "keep vents open," "special" or under "standard ventilation." In the latter case the vents will be closed in cold weather (32° F.). If under refrigeration there are several possibilities.

(1) Standard refrigeration in which the railroad ices the car before placing for loading and keeps it fully iced while in transit, icing at each regular icing station, until it reaches destination and delivers it to the terminal yards with its bunkers at

least two-thirds full for a stated charge. A certain time is allowed for loading. If additional ice is required due to delay in loading, the charge for same is in the tariff.

(2) Half-tank refrigeration is used on short hauls with certain commodities and can be secured by request of a group of shippers.

(3) **Rule 240.** The Perishable Protective Tariff provides that shippers may have a car initially iced with a designated tonnage of ice and moved to destination without re-icing in transit on payment of the cost of the ice, usually at $4 per ton, plus 20 per cent of the stated charge, or if the car moves in one freight zone, $5. Dry cars may be billed to be initially iced at a certain point, and for these movements mark the bill of lading "Shipped under Rule 240, ice at ——; do not re-ice." It is used in the case of short hauls with precooled products as apples, pears, peaches in the Eastern states.

If there is ice in the bunkers of a refrigerator car when loaded and no instructions are given by the shipper, the carriers may use their discretion in handling—they may keep it fully iced and collect the full stated charge or ship it as an iced car under Rule 240. All instructions must be in writing.

Heater service. The use of heater cars in connection with fruits is more commonly seen in apples than any other fruit. The cars are equipped with a false floor and sides, so that the packages will not lie against the walls of the car. A stove may be placed in the car between the doors. One messenger is allowed to travel either with one car, or three or four, to keep the stoves supplied with coal. In some cases oil heaters are used. There is always danger attending the use of stoves; for part of the load may become overheated and not enough be available for other parts of it. There are two bases of shipment: One in which the railroad assumes the responsibility for keeping the fires going and protecting the shipment from frost; the other in which the shipper assumes the responsibility. The degree of success in preventing the commodity from freezing depends not only on the heater but the weather and the insulation of the car.

Except for the use of heaters in Maine, in the movement of potatoes, there was not in 1924 any heater service in the territory east of Chicago and north of Richmond, Va. West of Chicago it is possible to secure it, hence the eastern shipper usually relies on warming the car with a stove before loading and fixing it up so that it may transport the commodity. The railroads in eastern territory contemplate the establishment of a heater service, this having been recommended by the Interstate Commerce Commission.

Notations on bills of lading. From time to time certain railroads attempt to secure waivers from shippers, as for instance, when refrigerator cars are ordered and not obtained in a reasonable time and the shipper is forced to use a box car, or when a railroad is unable to furnish ice for refrigeration and the cars go forward without ice. The signing of such waivers by shippers has no legal standing.

Diversion and reconsignment. Fruits, especially in the West, are frequently shipped East with the ultimate destination unknown. A daily record is furnished the shipper as to the position of such cars and this is the legal right of the shipper. The car may be sold while rolling and it is then diverted to its new destination. The California Fruit Growers' Exchange sells nothing except at destination. Daily, each representative in the important markets notifies the central office as to the condition of his market and if it is in good shape one or more rolling cars may be diverted, or if the cars have reached their first destination they may be reconsigned to their ultimate sale point. The railroad makes a charge for this work.

Storage in transit. Apples, pears and other commodities when moving from the West may be stored in transit. For instance they may be moved to Chicago as soon as possible after harvest and stored there until winter. This keeps the refrigerator cars out of the congested eastern yards, gets them back for another load in much less time than would otherwise be possible, and moves the fruit over the Rockies while the weather is good, thus reducing loss and damage claims. The fruit may be reloaded during the following months and sent to its destination on the through rate plus a storage in transit charge.

Demurrage. Forty-eight hours free time are given for loading and unloading a car, after which a per diem demurrage charge is made. It is important to note that during all of the forty-eight hours free time given for unloading, the contents of the car are in the custody of the carrier and they are liable for its safekeeping.

Tally charges. At certain terminals carriers unload the cars and tally the load and make a charge therefor. In all cases these freight charges are liens upon the property and when cars are shipped by growers on consignment they may find any or all upon their freight bill.

What the refrigerator car has done. The refrigerator car has made possible long hauls of perishable commodities. Prior to its advent there was no long distance movement of meat, dressed poultry and dairy produce, except during the winter months in the Northern states; nor was it possible to move many of our fruits very far from production centers. Now perishable commodities move every month of the year. The refrigerator car has stabilized rail movements and it transports its load with more certainty than the box car, thus saving food and reducing claims. Its use has (a) increased the length of the haul; (b) stabilized rail movements; (c) reduced loss and damage claims; (d) increased the volume of the traffic immensely; (e) increased the carlot movement. All of these factors are decidedly beneficial to the railroads as well as to producers.

Best size for a refrigerator car. Very large cars are undesirable. The meat packers have found that there is a limit to the size of the car. Their cars are much smaller than some of the refrigerators now being built. The large cars do not lend themselves to economical distribution of commodities. We want a carload of peaches, apples, pears or other fruits to be of such size that the maximum number of towns and villages may handle a carload. If the minimum carload is too large, distribution is limited and expense is increased. To distribute the present California cantaloupe crop carlot shipments are made to every town of 20,000 inhabitants and over. Therefore, from the standpoint of the shipper it is perhaps advisable to have a small carlot minimum, and a different rate for a carload of a higher minimum of the same commodity. If the minimum carload is placed at 30,000 pounds, it may mean that the commodity will be sent to the larger points of distribution only and from these another distribution made by express or by local shipment—both unsatisfactory and uneconomical. From the railroad's standpoint the refrigerator car involves too much tare for the load hauled. A refrigerator car weighs about twice as much as the amount of perishables which can be satisfactorily refrigerated therein. There is need for refrigerator equipment which is more economical to operate than that we now have.

Capacity loading. Fruits and vegetables cannot be loaded to the capacity of the car, like hay, straw, cotton—because in the case of cars under refrigeration the capacity of the car is determined by its ability to refrigerate the load, and not by the cubical capacity of the car. When these commodities are shipped under ventilation a similar condition prevails. In hot weather the roof is the most vulnerable part of the car, therefore perishables are kept away from it. With many commodities at least 36 inches should be left between the upper tier and the roof in a well-insulated car. In many of the cars there is only a half-inch of insulation, making it impossible to load such to even half of their cubical capacity with safety. A system of standardizing the refrigeration power of a car, in other words its capacity, should be worked out and our cars classified as in A, B, C or Class Z, so far as their value as refrigerators is concerned.

Expedited service and schedules. The average movement of all cars varies from 22 to 28 miles per day, or about a mile an hour. The usual run made at one time is about 100 miles at a speed of 10 miles an hour. On this basis, taking all cars, about 9 per cent of their time is consumed in actual train movement, about 11.3 per cent is used for loading and the same for unloading and the cars are standing still about 68 per cent of the time. Refrigerator cars are in actual movement about 20 per cent of their life. They do twice the work of the average car because they are on expedited service. Before refrigerator cars were developed some fruits were moved in ventilated cars halfway across the continent with safety and at a speed equal to that now given by the best service. Many boats, as those on the Hudson River, haul fruits and vegetables daily, throughout the season, in large and small lots at an average speed of 15 miles an hour, and some coastwise, Great Lakes and Mississippi River boats approach this, which is faster than many special fruit trains move. In the movement of apples from the Pacific Coast both refrigerator cars and box cars move in the same train and make the same schedule east. No difference in the freight rate, therefore, should be made on account of speed of movement for the use of a refrigerator car as against a box car.

The movement of perishable fruits, harvested when a high degree of maturity has been attained, thus insuring better quality to the consumers necessitates expedited service. It is more important, however, to have system in the service, to know when arrivals may be expected. This has led shippers and carriers to arrange schedules. Carriers do not hold themselves to maintain exact schedules or to make any certain market but in the case of unreasonable delay or where it can be shown that a shipment failed to reach a certain market as the result of the carrier's negligence, damages may be recovered.

Delays in transit. A slight delay in transit is not usually ground for a claim. A loss of market may be. In one instance when cars of California cantaloupes took eleven days en route instead of nine, a loss of $100 per car resulted from the two days' delay, even though the market remained stable, and on a trainload of sixty cars a minimum figure for the loss was $6,000. Another item not usually considered is interest. With carloads of produce of an average value of $1,000 each the interest on same at 6 per cent is 16½ cents a day, and a single day's delay on the million cars moved annually represents an interest charge of $165,000 per day. Bananas are sold by weight. They lose weight while in transit. The reduction of the time in transit from twelve to eight days effected a saving of 3 to 5 per cent.

Terminal facilities inadequate. Terminal facilities are deficient. This is especially true of New York City and in New England, but is equally true of Detroit and other rapidly growing cities. The yards are frequently much like a bottle—all traffic must go through the neck. New England is practically one terminal yard. The cars in New England and along the Atlantic Coast make but half the average speed they do elsewhere, the movement of all cars being about twelve miles in twenty-four hours, instead of twenty-four miles in twenty-four hours. Tracks will have to be provided for perishables, others for coal, others for "dead" freight, so that we may not have the remarkable congestion of hundreds of cars of perishable commodities sandwiched in among "dead" freight, and absolutely incapable of motion, resulting in serious loss; whereas, if the cars were placed so that they could be reached, they might be unloaded by truck. All cars containing perishable foods should carry a red card, furnished by the railroad, and it should be obligatory on the part of the shipper or agent to attach same so that the train crew can see it and give the car expedited service and more quickly "spot it" for placing at the terminal.

Car pooling. Not all parts of the United States require the use of refrigerator equipment at the same time. The value of centralized control or the pooling of equipment is that cars may be diverted to the parts of the country in need of them. It is not economical to keep refrigerator cars idle. They cost $3,000 each to build and there is a place for them at almost all times of the year.

Loss and damage claims. In 1919 the United States Railroad Administration filed a statement showing the economic waste on account of claims against railroads for alleged loss or damage to shipments of fruit and vegetables and other perishable freight during the calendar year 1914. This showed that in that year $32,375,617 was paid out by 180 carriers. Of this sum, $4,977,383 or 15.37 per cent was paid for perishables which included butter, cheese, eggs, meats, etc., the actual amounts of each commodity being as follows:

		Percent Claims Paid
Butter and cheese	$ 323,561	.999
Eggs	686,347	.212
Fresh fruits and vegetables	2,687,393	8.33
Meat and packing-house products	1,031,633	3.186
Poultry, game and fish	248,446	.767

The causes of the above losses are shown below:

	Ratio Proportionate Liability Percent	Amount Paid
Unlocated freight claim damages . . .	21	$7,767,000
Unlocated loss	16	5,156,000
Rough handling in cars	13½	4,300,000
Defective equipment	11	3,500,000
Unlocated loss, part of contents . . .	3	2,527,000
Delays, damage to shipments	6¾	2,187,000
Wrecks, freight damaged	6¾	2,100,000
Robbery—part of package	4	1,284,000
Robbery—entire package	2	659,000
Errors of R. R. employees	3	1,400,000
Destruction by fire	2½	791,000
Concealed damage to freight	2¾	924,000
Concealed loss of package contents . .	2⅛	688,000
Improper ventilation loss	2	1,035,000
Penalties and forfeitures	½	14,000
	Total	34,330,000
Credits—sale unclaimed freight . . .	6	1,955,000
	100	32,375,000

During 1919 the Class 1 railroads of the United States, that is the important lines and the same as those referred to above in 1914, expended $106,804,861 for lost and damaged freight. In 1921 the above carriers reported loss and damage claims paid to the amount of $14,500,000 on fruits and vegetables alone.

The payments on commodities is also shown below:

MONEY PAID BY 180 RAILROADS FOR LOSS AND DAMAGE CLAIMS (1914)*

	Percent	Amount
Grain	8⅓	2,718,000
Perishable fruits, etc.	8⅓	2,687,000
Live stock	6¾	2,218,000
Dry goods and notions	6¾	2,194,000
Furniture	5	1,626,000
Groceries	4½	1,434,000
Flour products	4⅓	1,395,000
Packing-house products	3	1,031,000
Household goods	3	1,011,000
Boots and shoes	2¾	912,000
Cement and clay products	2¾	903,000
Wines and liquors	2¼	740,000
Glass and glassware	2⅛	698,000
Eggs	2⅛	686,000
Iron and steel casting	2	676,000
Tobacco products	2	613,000
Vehicles	1¼	493,000
Stoves	1½	516,000
Cotton	1¼	404,000
Sugar	1¼	406,000
Butter and cheese	1	324,000
Agricultural implements	-¾	256,000
Poultry, game and fish	-¾	248,000
All other commodities	25	8,186,000
	100	32,375,000

The Transportation Magazine, June, 1919.

Edward Chambers, Vice-President of the Santa Fé Railroad, in testifying before the Senate Committee on Interstate Commerce in 1921, stated that nearly half the claims are paid on less carlot shipments. Less carlot shipments constitute about 4 per cent of the total tonnage, so that half the losses are paid on 4 per cent of the movement.

Producers' losses. It should be recognized that the amounts paid by the railroad companies do not meet the losses sustained by the shippers. For every claim that is collected there are several losses which are not. The losses which occur from deterioration, for which no claim can be made cannot be computed. Some estimates show as high as 30 per cent loss in transit on certain commodities from farm to consumer. The greater amount of such loss falls upon the producer. A car shortage and delay in receipt of cars causes losses in various ways, among these are: (a) The commodity may become over-ripe and unfit to ship, and be a total loss; (b) when the movement is held up the price differential at loading points in a commodity as staple as wheat may be 5 to 20 per cent below the market, and in a perishable commodity much more. The particular variety of fruit may fail to reach the market while it is in season and have to be sold at half the price it should have made; (c) it may necessitate a haulage and storage charge when storage is available at production points.

Loss from rot and breakage. A very conservative authority states that in fruits and vegetables the average loss from rot, decay and breakage in transit will run from 8 to 15 per cent, depending upon the commodity. A great many cars go through in satisfactory condition. A run of very hot muggy weather, or low temperatures resulting in freezing will increase the loss.

In an exceptional year, one of the bad ones for brown rot in the Georgia peach crop, Dr. Burger, of the United States Department of Agriculture, found the percentage of damaged fruit in cars at destination was about 22 per cent of the shipments. Some cars showed as high as 80 per cent of the fruit affected, and such were a total loss, other cars came through without any loss. If a shipment shows 17 per cent damage it is a very bad case. The average receiver who finds a car showing 10 per cent injured or damaged goods would off-hand place the depreciation in value at 50 per cent, and from a business standpoint, such might be correct. The cost of salvage, the damage done to the good fruit by handling and removing the defective fruit is so large an item that if the car showed 20 per cent of damaged goods the receiver might not want to handle it at all if the market was congested. All receivers of standing attempt to effect the best possible disposition of commodities received in this condition.

These facts are of importance to the shipper because they emphasize the importance of maintaining a high standard of grades at his end. Allowing a tolerance of 2 or 3 per cent of defective fruit to enter the package, small as it may appear, is going to be magnified 10 times when it reaches destination, especially if the market is weak. In the same way a tolerance limit of 5 per cent to 10 per cent, when same is used and the fruit is packed so that this percentage of damaged goods is in the package, may make the fruit unsalable in a year of low prices and when fruit is difficult to sell. Under such conditions the purchaser sees nothing in the package except the off-grade fruit. The 90 per cent of good fruit is sacrificed at the same price as the 10 per cent of trash. We must learn to keep the junk home. It will not pay the freight charges on it.

Decay and deterioration. Transportation facilities must be sufficiently rapid that the commodity may reach its destination before decay has wrought its work. Decay may be caused by insects, fungus diseases or bacteria, or by a physical breakdown of the cells, which might be called "natural decay." Fungus diseases are more or less under control through proper care in the orchard. Sometimes we have fungi which take possession of the commodity after it is loaded. Notable diseases of this type are the blue mold of oranges and lemons, and brown rot of peaches and plums. Physical breakdown can usually be delayed by control of temperature; incidentally, this will tend to control the speed at which certain diseases may multiply. The points that the grower must take into account are somewhat similar to those involved in storage.

The manner in which the crop has been grown. Crops that have not been taken care of should not be sent on long distance shipments. Plums, peaches or prunes from orchards which are showing brown rot should be immediately turned over for some local use.

Maturity at time of harvesting. Fruits must be harvested before they are over-ripe, yet they should not be gathered so green that they will not properly ripen in transit. They should be hard-ripe. Where proper cooling facilities exist, they may be allowed to become well ripe, a condition that is to be aimed at. Generally speaking, fruits that ripen on the tree are so much higher flavored that when they reach the consumer they immediately become the best advertisement. Such fruits as pears, bananas, lemons and certain others are naturally picked green—they ripen better off the tree than on.

Method of harvesting and handling. The use of mechanical devices for sizing, especially when these are run at high speed, may cause considerable damage. Punctures made by fingernails on fruits, and by the stems, in the case of apples, are frequent causes of complaint. The dropping of the fruit into the field boxes, rough loading, hauling on a wagon without springs, hauling on rough roads, pouring the fruit onto the table in a rough manner or into the crates and onto sizing machines, squeezing the fruit, in the case of peaches, as it is picked; crushing the fruit in the case of strawberries; the inclusion of over-ripe fruit, in the case of berries, with the sound fruit; rough handling in the case of grapes; sticking of the fruit with the point of the shears in the case of the citrus fruits—all tend to pave the way for a speedy death of the fruit and should be avoided.

The vessel used in harvesting the fruit is also of importance. Bags may be perfectly satisfactory and probably are best for some of the citrus fruits. Baskets are necessary for peaches, and pails may be used for certain varieties of apples, plums, etc.

The weather at the time of harvesting is important. High temperatures and a moist atmosphere aid decay. Muggy, rainy weather is favorable for the spread of the spores of diseases; all that is necessary is that the skin be punctured and under such conditions the fruit may rapidly decline in value during transit.

Precooling. If the weather is cool at the time of harvesting, precooling may not be essential. If the weather is hot, and the fruit is sent any distance precooling may be of vital importance. The tendency today is to run the fruit through a cold storage plant to precool or precooling may be done in the car. Precooling is used to a large extent for citrus fruits in California. It is now common in the Eastern states with peaches, apples and small fruits. In a good car the benefit of precooling will be felt for about four days after loading in fairly warm weather; after that time the temperature will be subject to the ability of the car to refrigerate and to the supply of ice.

Temperature in transit. With many of our fruits—peaches, plums, apples, pears and berries, but not citrus fruits—the temperatures in transit should be as low as possible, and yet not freeze the commodity. Few of the spores of our field diseases germinate at a temperature of 40° F., although most may continue to grow feebly at that temperature. If hot fruit at, say a temperature of 70° F., is placed in a car and the bunkers are kept filled with ice, it will probably be four days before the fruit has reached 40° F. if the car is a good one and the outside temperature not too high. The fruit nearest to the bunkers may reach that temperature in half of this time or less, but that in the center of the car may never reach 40° F. in some of the cars which we now have. There is frequently a difference of 15 to 20° F. in the temperature of fruit on the bottom tier and that at the top in different parts of the car. In loading the fruit into pre-iced cars, care should be taken to keep the doors closed as much as possible, and only one door should be open at any time. The load should be stowed to give the maximum of circulation of air. In cars which have an insulated bulkhead, salt and ice make a valuable freezing compound and should be used more than in the past. One runs a risk of freezing the commodity close to the ice boxes unless the bulkhead is sufficiently insulated. An exact record of the temperature of the car during transit may be secured by placing a couple of thermographs in the load. Such records are evidence and valuable for establishing a claim.

The cleaning of a car. Our railroads do not pay adequate attention to sanitation of the cars used for the transportation of fruits and vegetables. A refrigerator car laden with peaches infested to the extent of 80 per cent with brown rot was moved to a market and its contents dumped. They were worthless. The car was immediately sent south and loaded with apples. The car returned with its second load of brown rot-infested fruit. The fruit on the ends of the car, near the floor and the top layer was infected with brown rot, while the fruit in that portion of the car where there was little circulation of air, as between the doors, was sound. The car would not hold the commodity below 50° F. so the brown rot spores which thoroughly infested the car got busy on the apples and when these were unloaded the car was sent out again to spread more disease. Railroad employees know little about sanitation. Few shippers know anything about it. A few scientists who have had a chance to watch the ravages of disease among perishables in transit realize the need of some attention to this problem of transportation. Few of us know yet what kind of sanitary treatment should be given to the cars, yet most thinking men realize that the problem is one we need to reckon with and that it is of more importance than we have recognized.

Filing a claim. Claims must be filed within four months from date of arrival of the goods, on a form furnished by the railroad. The bill of lading, paid freight bill and all necessary supporting data must be attached thereto. Claims not paid during two years may become outlawed unless the shipper starts suit or takes the precaution to make all claims in triplicate, file two copies with the Interstate Commerce Commission, Washington, D. C., one of which will be returned, stamped with the date of filing. This is in the nature of filing an informal complaint.

The third copy is sent to the railroad. If the claim cannot be adjusted the claimant has six months after he has been notified by the Commission to that effect in which to file a formal complaint with the Commission. Claims should be based on the value of the goods at destination, at the time at which they should have arrived. Point of origin value is not the measure to use.

CHAPTER XXVI

MARKETING

The economic function of a market is to register a price which correctly reflects the sway of supply and demand, uninfluenced by control or restrictions of any form. A competitive market price reflects supply and demand.

The function of government in marketing should be to maintain the channels of trade free and open to all without favors or handicaps. Whenever legislative enactments supplant or check the free operation of economic laws the whole structure of society is injured.

Costs of production, weather and other factors govern the supply. Utility and desire govern demand. Desire or apathy plus scarcity or plenitude determine value. Increasing desire stimulates demand, hence we advertise. Cost of production does not alone determine price. Supply and demand determine price. Price is value expressed in terms of money. A correct price is one which will move the whole crop into consumption. Where the demand is elastic low prices tend to increase consumption, they also tend to curtail production. High prices tend to stimulate production and curtail consumption.

The marketing problem is ever variable. Weather is the most important individual factor in determining the size and character of the crops grown. Acreage is not nearly so important. With such crops as wheat, in the past thirty years we have had an increased acreage producing a crop below average size and a reduced acreage producing a large crop. Consumers demands are as variable as the weather and are frequently influenced by it. The consumption of milk is said to fluctuate as much as 25 per cent in one day in New York City. A week of cold weather in summer may almost stop the demand for lemons. Consumers' demands fluctuate. Production and consumption are "disorderly." "Orderly marketing" is a slogan without a meaning. There is no possibility of arranging the proper area to plant of any crop, for with such a staple as wheat, consumers' demands are as uncertain as the supply; and with fruits, the yields of which are fully as variable as that of wheat, the probability of determining the proper acreage to plant to furnish the proper quota per capita is remote. It is the dream of those who have no knowledge of the frailties, infirmities and changeableness of human beings and of the plants we grow.

The price of food and the price of labor fluctuate with the supply and demand. In the decade prior to the World War the price of food and the prices farmers received for their products rose on an average about 2 per cent per annum, and the consumers and the city press devoted much of their energy to the discussion of the "high cost of living." There was much ill feeling among consumers and all manner of plans for regulating the food supply and food prices were proposed.

Following the World War the turn of events found the average city worker enjoying a wage about double, or rather more than double the pre-war average, while farm products were retailing at 50 per cent above the pre-war level, the wholesaler was selling these commodities at 40 per cent above the pre-war level while the farmer received for one three-year period about 22 per cent more than in pre-war days.

With ample means to buy all the food they desired, and all kinds of fruits and vegetables actively competing with each other for sale, the American consumers have opportunity to discriminate such as never existed before, and this condition will tend to increase rather than diminish. Following the World War the low returns to producers brought on an agricultural depression, just as followed the Civil War and the Napoleonic wars in Europe. Some not well informed advised the organization of producers by the commodities they produced with the idea of fixing prices which would ensure a living to the producers, not realizing that even if the output of one commodity was restricted, there is nothing to stop consumers using a substitute. In fact, this is the usual procedure when the price of a commodity rises too high. The dominating position of the consumer will be apparent. In any marketing system the consumer and his requirements are paramount. The second factor in importance is the producer, he must cater to the wishes of a discriminating public, if he would prosper, or make them believe that they need the food stuff he has for sale. The third and least important factor, from any effect he may have upon the market, is the middleman, yet he is the one who often receives the most attention. The consumer constitutes the only market. The satisfied consumer constitutes the best market. Prof. James E. Boyle of Cornell University states that the producers may solve 90 per cent of the marketing problem on the farms, by producing what the consumer wants, the quantity and quality. The consumer wants cheap commodities, but if he must choose between cheapness and quality he takes quality first. The consumer controls production and price. The producer cannot control the consumer, he must serve him. There is no use trying to sell junk and expect it to stimulate consumption. Unclassified and C grade apples, except in times of great scarcity will not pay to ship. They will not defray the fixed charges against them and are a detriment to the wholesaler, retailer and the consumer and often a source of serious loss to the grower. If grown they must be used for by-products, unless one has a home trade for them.

Middlemen. The service of marketing is generally performed by one or more agencies commonly spoken of as middlemen. A middleman is one who performs a marketing service for another, either in selling or buying. A middleman usually can perform the marketing service more economically than the producer. He can reduce the cost because he combines the output of many producers, or he represents many. The selling cost may be lessened when producers combine to increase the volume or the number of articles they sell. In many cases the middleman also acts as a financial agent.

Each market has individual ideas as to the way in which the food should be packed and delivered. Some markets prefer large-sized fruits and other medium. A market like New York will pay a premium for fancy McIntosh and large Rhode Island Greening apples, and will pay 40 per cent more for such apples than certain other markets.

It is easier to cater to the whims and prejudices of a market than to try to change them. The shrewd salesman will carefully study his market. Certain days are better than others. In Pittsburgh, Friday is clean-up day of the week and is a poor day. Saturday is better for the reason that 60 per cent of the business done is with surrounding towns and the supplies of such for the following Monday are purchased in Pittsburgh on Saturday. In many markets Saturday is a poor day for goods to reach the market. In Boston half the week's purchases of fruits and vegetables at retail are made on Saturday and the retailers make their heavy purchases of highly perishable commodities on Friday

Terminal markets. Most purchases of fruits and vegetables at wholesale in eastern markets are made on inspection at destination. The amount sold by sample is not large. In New York City during 1921 out of 141,000 carloads of fruits and vegetables all but 30,760 or 22 per cent were sold on inspection. To permit inspection necessitates the bringing of all supplies to a central market and in New York City the major portion passes through the market on the lower west side of Manhattan Island. Here cars are unloaded and the commodities distributed by truck to the jobbers in the five principal jobbing markets and these men sell and deliver to the retailers. This system is common in many leading markets and so long as this system of purchase on inspection is maintained terminal markets will be required. If all commodities pass through one central terminal it enables both local and out of town buyers to make all their purchases at one place.

The present system of distribution. Climatic conditions have largely determined the location of fruit-producing areas. Usually these are situated at considerable distances from the consuming centers. This has led to the development of a rail movement of fresh fruits and vegetables in the United States, the like of which is not seen anywhere else. This movement cannot be made in a haphazard way; its successful operation depends upon system, and while the present system may not be all that one could wish, the field is open to anyone who has a better method than that now in use. A reward of no small magnitude awaits him. There is a wonderful field in which to work, for there are several needs which must be met and the system which can best render the service to these several parties is bound to secure the reward. The grower frequently lives 200 to 3,000 miles from the market and at the market end are the consumers who want that fruit. A parcel post service from grower to consumer is so limited in its operation as to be unthinkable. It would break the postal service to move the apple crop

Collecting into units. The present system consists of gathering the produce at production points into sufficiently large units so that carlots or solid train loads may be moved at one time. In the past, this work has been done by individuals, and the bulk of the present movement is so handled. During recent years the growers through their co-operatives have attempted to do the same thing. In California 75 per cent of the citrus crop is now gathered and packed ready for shipment by the co-operatives. The extension of the co-operative method to other fruits has been less rapid for many reasons, the complexity of the problem being perhaps chief. But whether done by the co-operative action of the growers or by individuals who specialize in collecting the crop ready for shipment, the system is the same. The method of selling may change. One problem of today is whether the co-operatives, owned by the growers, can do the work as economically as the individual operating his own business. Time will tell.

Rail shipments. If the commodity is to be transported by rail it must be prepared for rail shipment. Even when apples are shipped in bulk a certain amount of preparation is necessary. The fruit must be collected, ready for loading on a specific date; the car ordered; the work done in a proper manner—and then the next step must be taken, a market must be found. A carlot distributor or his agent purchases the car of fruit prior to time of loading or when loaded, or at destination. If the grower loads the car he may himself ship it and if he so wishes he can sell it to any agency that will distribute it. Few growers are prepared to retail their produce.

Ways of selling. The individual who cannot attend to the retail distribution himself has many courses open. He may consign the car to a commission merchant, have it sold by a broker, or sell it himself to a jobber or a carlot purchaser. Some firms operate on joint account. They guarantee the grower or shipper so much, and the two go 50:50 on whatever the car makes above this figure. Other firms maintain representatives in a district who receive large or small amounts of certain commodities from a pre-arranged group of growers, and combine these lots into carloads in order to secure a carlot movement; in other words, co-operation is in effect. The wholesale distributor gives his knowledge and service to the grower in return for a certain percentage on price realized. The commission houses in turn sell to retailers, or they break bulk at certain rail centers, making less than carlot shipments to wholesalers in markets which can not handle a carload. They may also sell in carload lots to other wholesalers. Frequently as many as ten highly competitive channels offer their services to the grower and seek to be employed as agent. Growers and consumers from time to time have stated that the costs incurred in the present system are too high for the service rendered. It is wise to remember that much of the service is labor. Freight rates are now fixed by law. Whether the grower, a carlot distributor, or the consumer ships the fruit, the charge is the same. With labor insisting that there shall be little if any deflation from wartime prices it will be difficult materially to reduce the charge for this service. Storage is a necessity and storage charges are in the main determined by the cost of the service plus a profit and the price which other industries are willing to pay for the same space. If butter worth 30 cents a pound wants the space it may be willing to pay more for it than will apples which have a wholesale value of 3 cents a pound or less. In certain cities the truckmen's organizations fix a scale of charges for cartage. Even loading and unloading of cars is done by labor which is unionized and whose rate of pay is fixed by the unions. These things are all part of the present system. The grower or the wholesaler who purchases fruit at production points may elect the channel of distribution, but once his decision is made he has little to say about the cost of the service. The fixed charges indicated above must be paid by the owner of the commodity.

The carlot distributor takes the whole country as his field. He may export part of his holdings to secure a wide distribution and the best market. He deals in carlots only. A jobber usually sells to retailers in his city and surrounding territory, and since the commodities handled are perishable and cannot be held for long and there are perhaps several men seeking to make a sale to the same retailer, the price received cannot be other than market value at the time. The same competition obtains among retailers. The public is quite sensitive to price, condition and quality of goods; and when buying power on the part of the public is low, the price paid to the grower is likewise reduced. The fixed charges, as freight charges and storage, may absorb the whole of the sale price or even more and the owner of the property may receive a bill for the deficit. The problem of distribution is so complex and the uncertainties of markets are so pronounced that many growers prefer to sell their crops as soon as grown for the best price obtainable and allow the purchaser to face these difficulties. The growers' co-operative organizations which grade, pack, store and market perishable farm produce (and some one must do this work) must be prepared to meet these problems. Because the commodity happens to be the property of a growers' organization it does not follow that the public will be any more appreciative of the service rendered.

Cost of marketing. Auctions make charges varying from 3 per cent to 7 per cent. West of the Mississippi River and in parts of the South the general method of distribution is through large jobbing houses which canvas the surrounding territory, often for a radius of 500 miles. Owing to the sparseness of population and the higher cost of operation they frequently sell at an average of about 16 to 20 per cent of the sale price. Records indicate a cost of doing business of about 14 to 16 per cent. In the East, commission merchants frequently charge 7 to 10 per cent commission, depending upon the service. Sometimes carlot sales made on track are handled on a 5 per cent basis. In store sales where commodities are jobbed out through the store, the usual charge is 10 per cent, in other words, charges are based on service. Some brokers operate on a basis of $10 to $25 per car depending upon the commodity. During 1917-1918 the United States Food Administration secured data in regard to over 4,000 firms which dealt exclusively in fruits and vegetables in the United States. The records showed that the average gross profit was 9.79 per cent of the total sales, of which 5.91 per cent was required to meet actual operating expenses, not including salaries, 1.46 per cent was used in payment of salaries and the net profit was 2.42 per cent. Many commodities move through the hands of two wholesalers and a retailer in their passage from the grower to the consumer. The carlot distributor often operates on a 4 per cent margin and the jobber on a 10 per cent, so that the average wholesale cost may average about 11 per cent to 14 per cent.

Selling direct to the consumer. There is a limited opportunity for a grower to make sales direct to consumers. This is feasible for the grower who has a small volume and who is located in close proximity to a large consuming center. Even then, as soon as there is any volume of movement the tendency is either to sell direct to the retailers or use the wholesale market as the most economical way of reaching the consumer. The time factor is of such importance when fruit is maturing that it usually takes all of the energy of the grower to harvest and pack without adding thereto the additional work of retail distribution. If it can be done economically it should be encouraged.

Consignment on commission. Some growers make a practice of selling all their fruit through commission merchants. In such cases, where the mark of the shipper is known favorably, high prices may be secured, especially if the grower has secured the services of a man who has the trade to which his fruit is best adapted. Other commission men work up a trade which reflects all of the various demands. Some cater to first-class trade, some to hotels and restaurants, some to general trade, and some large commission men will cater to all lines. When it is known that a shipment is coming, they plan to place it. Where there is personal contact of the grower and the commission man and full confidence is established between them, most satisfactory returns are secured. Frequently, however, the commission man's services are not sought unless there is difficulty in moving the commodity. Under such conditions, cars may be forwarded to be sold because the owner does not know what else to do and the market may not be in the best shape to receive the product, but if it must be sold, the commission man will try to secure full market value. Much dissatisfaction is due to this, especially when cars are shipped without first asking whether the market is in shape to handle them. It is advisable for all growers to ascertain before shipping which market is in condition to receive more cars. There are reliable houses in every city which make honest returns; and there are also unreliable houses which may not make honest returns. In many states commission merchants are under license and bonded and a list of same can be secured from the State Department of Agriculture. The produce trade organizations publish their lists of membership. The financial rating of firms should be secured from the produce trade rating agencies, Bradstreet or Dun before making shipments.

The broker. If one produces considerable fruit, it may pay to arrange with a broker to sell it. In this case, the commodity is sold before it leaves the hands of the grower. It may be sold either on sample or grade. The establishment of grades has made it possible to sell more fruit f.o.b.

Association selling. The establishment of community packing-houses by growers' organizations has been pushed, particularly in the West, in the hope of encouraging more f.o.b. sales.

Standardization and the better packing of the fruit, together with the improvement in methods of production and varieties are fields in which much can be done. The California Fruit Growers' Exchange, one of the oldest and best of these organizations, harvests, packs and sells the fruit of its members, but it makes its sales only when the car has reached destination and then through the regular wholesale distributing channels. It sells to the same carlot receivers and jobbers that the individual would, and is the direct representative of the grower. It has not proven economical for it to attempt to do more. It would not pay for it to attempt to reach the retailer direct.

Auctions. The auction method of selling fruit on arrival is increasing in popularity in some markets, and has failed to establish itself in others. It is more often used when fruit is shipped considerable distances and is standardized. It is an expeditious manner of distribution. Anyone with established credit can bid. The seller or his agent may withdraw the property at a certain point in the sale but cannot bid upon his own goods. A recent experiment is the f.o.b. auction, which sells rolling cars of standard packs of fruits and vegetables which have been inspected at shipping point. These are offered simultaneously in various cities, all bids being wired to a central point as made. It takes but two minutes to sell a car and the shipper may receive his money in twenty-four hours.

The jobber. The jobber purchases the fruit outright. Knowing his trade, he buys in accordance with his anticipated requirements. Selling direct to a man who makes a specialty of getting all there is in the business of distribution frequently nets the grower as much as can be secured. These men run considerable risk, and while they may make a good profit sometimes, they often sustain serious losses. Some of them handle goods on commission as well as purchase. Jobbers usually confine their business to a city or its immediate neighborhood.

Carlot distributor. A carlot distributor may act as a broker or he may be the direct representative of an association of growers or again he may be a merchant, buying on his own account. He sells in carlots only, while a jobber may sell single packages to the retailer.

Peddling cars. In the Central states it was not uncommon for growers to peddle carload lots of apples. In a recent year it was reported that fully half of the Nebraska crop was moved in this way. The method is most highly developed in the Central states, notably in Missouri, Iowa, Nebraska, Colorado, etc.. and recently it has been used by growers of Florida citrus.

On June 21, 1917, the Interstate Commerce Commission decided this plan of selling was illegal. At the present time the situation is about as follows: If the goods are sold in the car they are peddled. If inspected in the car and the selling takes place somewhere else than in the car, for instance in a store, in a wagon off the railroad's right of way, or even in the street, it is legal, and the railroad has nothing to say about who shall remove the goods. No other decision could be reached because many carloads are bought through co-operative associations, such as granges and consumers' organizations, and in these cases the individuals go to the car and get their share. In these cases it is not peddling. The grower of apples or other fruits, therefore, can ship his car in this way if he wishes. A soap box may be said to be an office. Standing room in a coal office is sufficient and from this point legal sales can be made, orders taken to deliver to the purchaser, and a man can be placed in the car who will recognize the order and deliver the goods. If a grower finds on reaching his destination that the market is not what he anticipated and that another point is more promising the car may be reshipped. Refrigerator cars need to be kept in service, they were not built for use as stores. The delays incurred have led railroads to consider increasing the demurrage charge, and the curtailment of this delay rests with them.

Co-operative marketing. The United Fruit Companies of Nova Scotia, Ltd., is a co-operative selling and buying corporation made up of some forty local associations, who own community packing and storage plants at various points in the Annapolis Valley, N. S. In 1918 this organization handled $1,433,235 worth of goods at a cost of 1.73 per cent of the turnover. The subscribed capital is $57,600 with $200,000 authorized. The gross expense was $23,878, of which $10,615 were for salaries. They sell apples and potatoes—apples in England and Canada, and potatoes in Cuba. They purchase in large units the fertilizers, spraying supplies, seeds, feed, flour and packages that their members require. This organization has undoubtedly had a stabilizing effect upon the market and is an aid to the growers in many ways. Some growers are dissatisfied from time to time and some units have separated from the central organization. One of the chief benefits claimed for such organizations is that larger units of uniformly packed lots of fruits are available, and that such will be of much more interest to buyers than miscellaneous lots. The difficulty with many of these packs is that the small lot from one orchard is not comparable with the small lot from another, even when uniformly sized. This is a serious problem and may yet necessitate the marking of each separate grower's lot, which would materially aid in selling. As it is now, there may be ten distinct lots of varying value in a carload of A grade apples of one variety. When individuals reach a certain size in their operations the benefit from such co-operation ceases, and other factors must enter into the case to justify the continuation of the co-operative effort. This is apparent in Nova Scotia and in every other apple-growing region where co-operation has been attempted. It takes a very high type of organizing ability to maintain a co-operative enterprise. Such organizations are most successful when certain conditions prevail as for instance: (1) When the units of production are small. (2) When the financial ability of the producers is limited. (3) When the markets are distant and only highly developed and well-packed articles will pay to produce or ship. (4) When the industry is complex and so highly specialized that one man can look only after production, the association then merely becomes a collecting, standardizing, packing and selling agency for the growers. One of the chief values such organizations may have is in the savings they effect for their members, rather than in the benefit they are as sales agents.

Principles in co-operation in agriculture. G. Harold Powell, the well-known pioneer in co-operation declared the fundamentals of co-operation to be:

1. The organization must consist of producers exclusively. It must be managed by them and the profits must return to them. No one else should be allowed to furnish any of the capital.

2. The capital contributions of each member must be progressively proportionate to the individual's interest—either his sales or purchases.

3. To be co-operative, any earnings or profits shall be returned to the members in proportion to their shipments. These are not divided upon the capital involved but upon the amount of business done by each member.

4. The foundation of a co-operative organization is men, and its reason for existence is that it be for the mutual help of its membership.

5. To be successful the organization must grow out of an economic necessity. Usually one man one vote is the best form of representation.

6. The organization should be formed to handle one crop or commodity, and if the area involved be small and the members know each other well the chances of success are increased.

7. Federation of local units for mutual protection of all is a natural evolution of successful operation.

8. A capable manager who will maintain a correct attitude in regard to his duties to the membership and to society at large is a necessity.

Too much emphasis cannot be laid upon the necessity of the organization restricting its activities to its own field. No organization can exist as both a buying and selling organization. It must function primarily either as a selling agency or a purchasing agency. The two businesses are so antagonistic to each other that the same force cannot be developed to perform both services equally well. If the organization is large enough, so that two separate and distinct organizations can be developed under the one name, then we really have two organizations and the business may succeed, otherwise it cannot live.

Ways in which fruit can be sold by the grower:

1. Retailed at the farm.

2. Sold direct to retailers or to a special trade—hotels, restaurants, canners, driers, makers of jams, jellies, fruit juices, glacé fruits, etc.

3. Sold on the trees, buyer to pick and pack, either lump sum, per package or by weight.

4. Sold picked, tree run, buyer to pack.

5. Sold picked, tree run, culls out, or lower grades and small sizes out, buyer to pack.

6. Sold packed, to wholesale cash buyers in wagon loads or carload lots, with or without cash advances to assist the grower to finance harvesting and packing.

7. Packed and sold through a broker.

8. Packed and sold at auction, either f.o.b. or at destination.

9. Packed and sold in transit or in storage.

10. Packed and sold on commission, the grower being sole owner of the property.

Many variation from this are seen, as:

11. Commission merchant furnishes the operating capital to grow, pick and pack the crop, with or without interest; the grower pledging himself to consign the crop to be sold by the firm making the advances.

12. Commission merchant advances capital to finance harvesting, packing, storage, etc., and deducts same from proceeds of shipments as received and sold.

13. Commission merchant picks, packs and stores the crop at cost plus a profit and sells to the account of the growers on an agreed commission with or without cash advances.

14. Commission merchants may honor drafts attached to bills of lading of rolling cars, thus aiding in financing the shipper.

15. Commission merchants maintain representatives at loading points who receive small lots and attend to the forwarding of same by express shipment or they combine shipments and secure carlot freight rates. Cash advances may be made by such agents at the time of shipment.

16. Packed and sold on joint account; (a) On a guaranteed minimum, plus half the profits above costs of handling. (b) On a base price and buyer and seller go 50:50 on profits and losses.

17. Through a growers' co-operative packing establishment: (a) In which the co-operative picks, packs, grades and sells the fruit, as the California Fruit Growers' Exchange. (b) The grower harvests, the organization furnishes the packages, packs, stores and sells or manufactures and sells. (c) The grower harvests and furnishes packages and delivers to the packing plant, the co-operative grading, packing, storing and selling the fruit.

Fruit may be sold for the home or export trade.

Late varieties of apples may be stored in common or cold storage and marketing may extend over six or eight months.

Retail agencies. Apples and other fruits to a varying extent are retailed in towns and cities, through certain well-recognized channels, which may be stated about as follows: (a) fruit stands; (b) fancy grocers and fruiterers, who cater to an exclusive trade, frequently on a credit basis; (c) grocers catering to general trade, usually on a cash basis, and (d) hucksters or street peddlers. It is obvious that the costs of distribution under these systems will be markedly different; that they will need many kinds of fruit for their trade, and that no comparisons can be made in the costs of distribution under the several conditions, without giving consideration to the service rendered. The margins on the different commodities vary.

Fruit stands. The men usually sell limited quantities. There is a marked tendency in the case of apples to use box fruit. Fruit stands usually show a gross turnover of about two and a half or three times the initial cost. In 1914 when western Jonathans were selling, wholesale, at $1 to $1.25 a box in October and November, the apples, sizing 150 to the box, were retailed at two for 5 cents, or $3.75 a box. The trade is limited and the price appears disproportionately high. Yet the net returns per day for a man engaged in the industry may be small. Naturally, when the weather is severe this trade is affected and sales are reduced, so that open winters are frequently very important in their influence on the movement of the crop so far as the fruit stands are concerned. There is always a percentage of loss from unsaleable fruit.

Fancy grocers. This trade buys the best apples. It is customary to take the apples from the boxes, repacking in small trays or splint boxes. Many of these grocers do not attempt to stimulate consumption—they may give credit. Any person buying for cash tends to reimburse the handler for the losses which follow the giving of credit unwisely. During the war, there was a tendency to bring more trade on a cash basis, which will be an advantage. The retail price in such places frequently bears no relation to the cost. In fancy grocery houses in New York cranberries sold at 20 cents a quart when the wholesale price was $7.50 per barrel and the price was the same when the wholesale price was $21 a barrel.

Grocers catering to general trade. During 1914, in St. Louis on October 13 and 14 the purchase price of the apples handled by ten retail grocers varied from $1.55 to $3 a barrel. The selling price varied from $3 to $5 a barrel. The author has found 30 to 35 per cent gross profit relatively common in the retail distribution of fruits and vegetables in New York in stores catering to the average trade. It is felt by many that sales could be made on a closer margin and that grocers should handle larger quantities upon small margins. In Boston there are stores operating on a 20 per cent margin on a cash and carry basis, and up to 33 per cent margin where credit is given. In another city, as an illustration of a very close margin, a record of a sale of 118 barrels of apples through 5- and 10-cent stores was secured. These apples were handled on a margin of 21.8 per cent of the consumer's dollar, a turnover of 128 per cent on cost. Of the total paid by the consumer, a little over 38 per cent was returned to the grower for his fruit on the tree. This is regarded as a very satisfactory statement.

The distribution of the consumer's dollar in a sale of 118 barrels of apples distributed through 5- and 10-cent stores is shown below:

DIVISION OF CONSUMER'S DOLLAR FOR APPLES

	Retail costs per barrel	Per cent of consumer's dollar
Grower received (on the tree)	$1.455	38.49
Cost of barrel, picking, grading, packing and hauling	.66	17.46
Fruitgrowers' assoc. selling charges . . .	.135	3.57
Freight, origin to destination	.416	11.00
Cartage at destination (depot to store) . .	.05	1.31
Loss (shrinkage) to wholesaler	.032	.84
Cost to wholesaler	2.748	——
Wholesaler received	.208	5.53
Cost to 5- and 10-cent stores	2.956	——
5- and 10-cent stores received	.824	21.80
Price paid by consumer	3.78	100.

There is a possibility that if individuals and growers' organizations could connect directly with cash groceries which were capable of distributing carlots daily, the industry would benefit, especially in years when there are abundant crops, but the percentage of the crop which appears to be capable of movement in this manner is not large. Fruits and vegetables are sold at retail on inspection, and it takes more time than it does to hand out a package of standard groceries. Chain store managers find that, except where the work can be departmentalized, it is not profitable to have the fruits and vegetables exceed 6 to 9 per cent of the total sales of the store. It is particularly desirable that people start to eat apples early in the fall and that they be kept well supplied during the earliest months of the winter so as to acquire the apple-eating habit. This tends to insure a cleanup of the crop at fair prices which is to the best interest of all. Grocers complain of inability to sell all the apples in the barrel, owing to the lack of uniformity in the contents. Retailers of barrel apples in New York assured the author that on the average 20 per cent of the contents of the barrel are below grade, bruised or undesirable and they made their barrel purchases with this in mind. They favor the box because it is more honestly packed, and the fruit is not bruised, the latter being as important as the former.

Hucksters. In Philadelphia in 1914 there were 1,600 pushcartmen. These practically disappeared during the war period. These men are a very important factor in distributing perishable commodities. They are true distributors. They find customers and dispose of large quantities of produce. They handle box apples when the price is low enough, or they buy barrel apples when they see a margin. A number of these men are given short credit by the commission men and handlers who know them. In Pittsburgh 60 per cent of the local trade is probably done with grocers and hucksters on a weekly credit basis. This is an inducement for the hucksters to take on the fruit and insures the placing of fruit before the public at an attractive price. Naturally, severe winters cut off this trade and have a most marked effect upon the apple movement. These men handle large quantities of bulk apples.

Bulk apples. Returns of carload receipts in cities such as New York, Chicago and Detroit, show that in the months of October and November, 16 per cent of the shipments into New York are bulk apples; 35 per cent of those sent to Chicago, 43 per cent of those going to Detroit, and 20 per cent of those going to St. Paul are bulk apples. Bulk apples should be shipped to markets which unload and sell for local requirements. Many small markets use bulk apples. Pittsburgh is a poor market; it tranships at least 60 per cent of its receipts in mixed carlots. Bulk apples do not lend themselves to such treatment.

With the marked increase in the price of packages, there will be a tendency to move larger proportions of the more common apples in bulk during October and November when we have full crops. There is a marked tendency to put a large percentage of worthless fruit in the bulk apple shipments. Ordinarily, on the

Chicago market, probably 25 per cent of the apples shipped in bulk should have been used for some other purpose. In Chicago these off-grade apples were so poor in quality and grade that had they been shipped singly they would not have brought the charges against them. They merely tend to reduce the prices received, and ought to be used for cider, chops, or for other dry-house purposes.

Costs in handling box apples. Two carlots of Jumble pack Jonathan apples were sold through a broker to a carlot receiver in Kansas City in 1920 at $1.30 a box. The broker received 4 cents brokerage. The carlot receiver sold them at 5 cents advance, or $1.35 per box to a jobber, who in turn sold them in small lots to hucksters at $1.60 a box. These hucksters resold them at 4½ pounds for 30 cents or on a basis of $3.25 a box, provided all were sold without waste. The grower received 12 per cent of the consumer's dollar or 39 cents a box out of which he had to pay all expenses of production, packing, package, etc. The transportation companies received 87 cents, or twice as much as the grower. The wholesalers received about 10 per cent and the retailer about 30 per cent of the consumer's dollar. Clearly it did not pay the grower to produce or handle this cheap grade of fruit in this manner in 1920.

Another lot of Extra Fancy Jonathan, 126 size, were purchased by a carlot receiver in storage in Kansas City for $3.30 a box. The broker received 4 cents per box. These were sold by the carlot receivers to jobbers at $3 a box, entailing a loss of 30 cents. The jobbers resold them to retailers at $3.50 a box and they sold the fruit at six for 25 cents or $5.25 per box. This represents a normal transaction at the time. The grower received 45.5 per cent of the consumer's dollar; the railroads, 16.6 per cent; the wholesalers (carlot receiver and jobbers) 4.5 per cent (too low); the retailer, 33 per cent. The wholesaler paid too much and the grower got it. Probably 40 per cent is a common figure for the grower's share for such fruit under normal conditions.

In 1922 Fancy McIntosh apples were retailed by the New York grocery trade at 10 cents a pound. The retailer paid 7½ cents a pound for them in New York and had 25 per cent gross profit. The commission and cartage were 11 per cent of the consumer's dollar, freight was 8 per cent and the grower received 56 per cent of the consumer's dollar for the packed fruit, f.o.b., the cars. Picking, packing and haulage absorbed nearly 17 per cent more, leaving the grower 39 per cent of the consumer's dollar for the fruit on the trees. This was a high return to the grower, and a low cost for retail distribution, because every apple was saleable at the same price and there was no loss from shrinkage or damage.

In Boston for the seasons 1920-23 the gross profit on apples handled by six firms was 28.6 per cent, their margins on all fruits and vegetables varying from 20 per cent to 35 per cent.

Market reports. The United States Bureau of Agricultural Economics issues a daily market news report showing the daily loadings and unloadings of certain fruits and vegetables and the prices in certain leading markets. The daily reports are mailed free. Monthly, seasonal and comparative records for a term of years are also prepared for distribution. Leading distributors in all the important markets maintain a daily market news sheet which is furnished free. The trade and daily press also feature such news.

Car rejection is a possibility with any shipment. Data show about 1.6 to 1.7 per cent rejection in carlot shipments of fresh fruits and vegetables. From 20 to 30 per cent of all rejections were on cars which had been an unreasonable time in transit, over a third on account of the commodity being below grade, some were frozen, other causes were wrong size, wrong variety, etc. Shippers report 40 per cent of the rejections as unjustifiable and 50 per cent as doubtful.

Carlot inspection. To aid shippers, the United States Department of Agriculture maintains a force of inspectors at all principal unloading points, who inspect cars upon request of the buyer or seller and certify as to the grade and condition of the commodity, and such report is evidence in a court of law. The charge is nominal. Inspection and certification at loading point has been instituted at certain important shipping centers. In addition, privately owned and operated inspection service is available and the railroads themselves maintain a car inspection service for their own protection.

Best time to sell. Whatever program is mapped out, it should be adhered to. If the grower arranges to store part of his crop he should follow the plan rigidly year after year; or it may be wise after studying the conditions to make a price at which he will let go. *There is a time to sell, and it is when people want to buy.* If we go back of wartime, previous to 1914, we may get an idea of normal business conditions. One year is no guide, so ten years are taken—the decade 1904-05 to 1913-14 inclusive. The following are the New York prices for five varieties of apples:

AVERAGE WHOLESALE PRICES OF BARREL APPLES IN NEW YORK (1904-13)

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Baldwin	2.49	2.72	3.03	3.37	3.63	3.83	4.21
R. I. Greening . . .	2.81	3.09	3.29	3.41	3.69	4.13	4.31
Tompkins King . .	3.05	3.23	3.39	3.73	3.65	3.35	—
Northern Spy . . .	2.80	2.94	3.08	3.62	3.85	4.08	4.42
Ben Davis	2.43	2.40	2.52	2.72	3.41	3.44	3.92

In the table below is shown the gain in price over the October price from month to month:

AVERAGE MONTHLY INCREASE IN PRICES OF BARREL APPLES IN NEW YORK (1904-13)

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Baldwin	.26	.49	.80	1.14	1.40	1.60	1.98
R. I. Greening	.41	.70	.90	1.02	1.30	1.74	1.92
Tompkins King	.22	.40	.56	.90	.82	.52	—
Northern Spy	.62	.76	.90	1.44	1.67	1.90	2.24
Ben Davis	—.02	—.05	.07	.27	.96	.99	1.47

The following facts should be considered in reading these figures: (1) The above are averages; some years there will be losses, other years corresponding gains. (2) Each variety has its season; Tompkins King is rarely held after February because it loses flavor; Rhode Island Greening and Northern Spy are usually not held after March. Ben Davis is bought for long keeping, those which are forced on the market in November and December are sold at somewhat of a sacrifice. (3) If the prices secured for the twenty-year period, 1893 to 1913, be taken, it will be seen that during that time it did not pay in ordinary years to store fall and early winter apples. The greatest margin of profit was secured by selling as fast as harvested. (4) With winter apples, properly handled, there is a margin of profit in storing. This benefits all. It enables the man who must sell to get a better price because the portion stored is off the market for the time being; it benefits the consumer because it ensures a steady supply of apples. Not all can hold for the long price. There is but a small portion of the crop which can be stored so that it will hold up for the late market. Usually ripening of the fruit forces sales.

Cost of storage. The average costs as secured from several cold storages in New York for the same decade, are as follows:

STORAGE COSTS, BARREL APPLES, IN NEW YORK (1904-13)

	Jan. 1	Mar. 1	May 1
Storage charge	.25	.35	.40
Cushions	.04	.04	.04
Carting	.025	.025	.025
Car preparation	.025	.025	.025
Extra commission	.08	.14	.20
Interest	.021	.043	.064
Miscellaneous	.04	.05	.06
	.481	.673	.814

(a) Storage charges for the first month were 15 cents, 10 cents for the next month, or 40 cents for the season. (In 1922 storage in Western New York cost 60 cents for the season and in New York City more.)

(b) If apples are held a month they may become slack and need a cushion.

(c) In city storages there may be a cartage charge and in many cases there was an additional rail movement of 5 or 6 cents per barrel which is not included. (In 1921 freight rates for the United States as a whole were 176 per cent of the 1914 level, and in the Eastern states 211 per cent of the 1914 level and charges for refrigeration were materially higher.)

(d) If shipments are made in winter the car must be lined to prevent freezing.

(e) The increase in the sale price will necessitate the payment of a larger sum for commission, hence the charge of ''Extra Commission.''

(f) Interest at 6 per cent on the money tied up is legitimate.

(g) Miscellaneous charges embrace—cost of trips to storage, correspondence, loss of barrels, and if repacking takes place there will be a shrinkage which may be more or less and sometimes is quite serious. No repacking is included in these figures.

Profits. Taking the above figures it will be seen that the probable gross profit on a barrel of Baldwins during this period was 32 cents on January 1; 73 cents on March 1 and $1.17 on May 1, if no repacking is necessary. Out of this the owner of the apples is entitled to deduct the cost of his own services before a profit can be declared. The man who goes out and buys apples to store has an additional expense which must be met from some source. With the return to the pre-war level in the price of apples in 1920 and the maintenance of nearly wartime prices for packages, labor, supplies, storage, freight rates and all the services incidental to packing, transporting and storing apples, the problems of storage and ''when to sell'' are rendered complex.

The turnover. In storage apples there is but one turnover in a season. Turnover is a big item in successful merchandising. Some men state that money is made by good buying. It is true, but the wholesaler who can turn his money once each month and make 2 per cent net on the average will not go broke. He can undersell the man who turns his goods but four times a year. The latter would need to make 6 per cent profit on each transaction to make the same income, and this would tend to restrict his sales. The man buying apples to store must consider this factor as well as all the other risks which attend the holding of fruit. The chain stores when efficiently managed are very striking illustrations of the value of a quick turnover.

Time and way to use an apple. Every apple has a use. Some are better for dessert, others for baking or sauce. The consumer may be disappointed in a fruit because he does not know how to use it. The degree of maturity of the fruit is important; an unripe Stayman of good size may not be good to eat out of hand and yet it will make excellent apple sauce. Rome Beauty, when grown to large size and harvested before fully ripe, is an excellent apple for baking or sauce, much better than when fully ripe. Small-sized apples of such varieties as Delicious, Ben Davis and Arkansas, are usually much poorer for any use than large-sized fruits of these varieties. Small fruits of most varieties will keep better than the largest sizes; they appear to be less fully matured. All varieties of apples are usually harvested by October and may be offered for sale, but such varieties as Yellow Newtown, Ben Davis, Winesap and Rome Beauty are not then in season and the purchaser of such for immediate use will be disappointed. The time of ripening of a variety depends upon the location in which it is grown. For instance, Yellow Transparent may be ripe in June in Alabama, but not until August in New York.

The uses of the various varieties are shown below:

Variety	Season	Condition	Dessert	Sauce	Baking
Yellow Transparent	June to Sept.	Unripe	Poor	Excellent	Good
		Ripe	Good	Good	Fair
Oldenburg . . .	July to Sept.	Unripe	Poor	Excellent	Fair
		Ripe	Fair	Good	Good
McIntosh . . .	Sept. to Dec.	Unripe	Good	Excellent	Excellent
		Ripe	Excellent	Excellent	Excellent
Wealthy . . .	July to Oct.	Unripe	Poor	Excellent	Excellent
		Ripe	Excellent	Excellent	Good
Winter Banana .	Sept. to Dec.	Unripe	Good	Fair	Poor
		Ripe	Excellent	Fair	Poor
Delicious . . .	Oct. to Feb.	Unripe	Good	Good	Poor
		Ripe	Excellent	Poor	Poor
Jonathan . . .	Nov. to Dec.	Unripe	Good	Excellent	Good
		Ripe	Excellent	Good	Poor
Grimes Golden .	Nov. to Feb.	Unripe	Poor	Excellent	Good
		Ripe	Excellent	Good	Poor
Stayman . . .	Dec. to Feb.	Unripe	Poor	Excellent	Good
		Ripe	Excellent	Good	Poor
EsopusSpitzenburg	Dec. to Mar.	Unripe	Good	Excellent	Excellent
		Ripe	Excellent	Excellent	Good
White Winter Pearmain . .	Dec. to Mar.	Unripe	Poor	Good	Good
		Ripe	Excellent	Poor	Poor

Variety	Season	Condition	Dessert	Sauce	Baking
Rome Beauty .	Dec. to Apr.	Unripe	Poor	Excellent	Excellent
		Ripe	Good	Good	Good
Yellow Newtown	Feb. to June	Unripe	Good	Excellent	Excellent
		Ripe	Excellent	Excellent	Good
Winesap . . .	Feb. to June	Unripe	Good	Excellent	Good
		Ripe	Excellent	Good	Good
Wagener . . .	Dec. to Mar.	Unripe	Poor	Excellent	Excellent
		Ripe	Good	Good	Poor
Arkansas Black .	Feb. to May	Unripe	Poor	Excellent	Excellent
		Ripe	Poor	Poor	Good
Ben Davis . . .	Feb. to June	Unripe	Poor	Good	Good
		Ripe	Fairtogood	Good	Good
Baldwin . . .	Nov. to May	Unripe	Poor	Very good	Good
		Ripe	Very good	Very good	Good
R. I. Greening .	Oct. to Mar.	Unripe	Poor	Excellent	Excellent
		Ripe	Excellent	Excellent	Very good
Northern Spy . .	Dec. to Mar.	Unripe	Poor	Excellent	Excellent
		Ripe	Excellent	Very good	Very good
Tompkins King .	Oct. to Jan.	Unripe	Good	Very good	Very good
		Ripe	Very good	Very good	Very good
Twenty Ounce .	Sept. to Dec.	Unripe	Poor	Very good	Excellent
		Ripe	Poor	Very good	Very good
Wolf River . .	Sept. to Oct.	Unripe	Poor	Very good	Very good
		Ripe	Poor	Good	Good
Maiden Blush .	Aug. to Sept.	Unripe	Poor	Excellent	Very good
		Ripe	Good	Excellent	Good
Alexander . . .	Aug. to Sept.	Unripe	Poor	Good	Very good
		Ripe	Poor	Good	Good
Fall Pippin . .	Sept. to Dec.	Unripe	Poor	Excellent	Excellent
		Ripe	Good	Excellent	Excellent
York Imperial .	Oct. to Mar.	Unripe	Poor	Very good	Excellent
		Ripe	Good	Good	Good

CHAPTER XXVII

EXPORTS AND IMPORTS

With the exception of the interchange by rail with Canada and Mexico and by ferry to Cuba, our exports and imports of fruit move as ocean freight. In the decade 1913 to 1922 our exports of fruit—fresh, canned and dried—varied from about 38 million dollars in 1913 to 80 million dollars annually in the latter years and our imports of fruit of all types ranged from 28 million dollars to about 45 million dollars in the latter part of this period.

Exports. The exports of fresh fruits comprise chiefly apples, oranges, pears, plums, berries, lemons, grapefruit and some cherries and peaches. There is a heavy movement of dried raisins, prunes, apricots, peaches and apples, also of canned peaches, pears, pineapples and other fruits. In some years the movement is reduced, in others years it is large, depending upon competitive foreign supplies, transportation costs and other factors. The export trade has proven to be of great value to the producers of fruit in America, affording as it does an outlet for surpluses which, if forced onto domestic markets, would lead to demoralization with all its unfavorable influences on production. The disposition of the surplus of a commodity often determines the value of the whole. Not infrequently the price received for export apples has determined the price of all. Without this outlet, domestic market conditions would many times be very unsatisfactory. The importance of the export trade has not been realized, nor its remarkable growth appreciated. Because of the increasing production of fruits in this country it is essential that the areas of distribution be widened to the utmost. This can be accomplished by proper grading, suitable containers, efficient inland and ocean transportation. Proper ocean transportation is all-important.

Necessary factors in ocean transportation. In the movement of fresh fruits, refrigeration when used, must be dependable, adequate and efficiently operated. Ventilation of unrefrigerated cargoes should be scientifically applied; forced draught ventilating systems are necessary. The stowage should be efficiently done. Thorough supervision should be maintained at all times, both in transit and during loading, stowage and unloading. Thermographs should be installed to show the temperature during transit to measure the efficiency of the service. Special care should be taken while loading, stowing and unloading to prevent breakage and bruising; to this end the best and most approved appliances should be installed. Better terminals should be provided to protect the commodities while waiting to be loaded and after unloading. Avoidable delays should be eliminated and schedules maintained as far as possible: this aids shippers and receivers and tends to stabilize markets. To secure the above it is essential that shippers, receivers and the steamship companies co-operate to study the problems, that shippers deliver their commodities to the steamship lines in good condition and properly packed in packages of sufficient strength; that shippers arrange for space in ample time and deliver the commodity in time to permit careful loading and stowage. Joint committees of shippers, receivers and steamship companies are now working co-operatively to improve the service.

Imports. Under normal conditions about half our imports of fruits, stated in value, are bananas, principally from Central America and the West Indies; pineapples from Cuba; lemons from Italy and Spain; currants, dates, figs, olives, raisins and others are imported dried or preserved. During recent years fresh fruits as peaches, plums, grapes, have been imported from South America and South Africa, their fruits ripening during our late winter months.

Exporting the apple. The apple is the leading export fresh fruit. Usually from 10 to 14 million dollars' worth are sold annually. Great Britain leads all other countries combined as a receiver and consumer of American apples. Canadian apples enter the same market.

Ports of export. New York is the leading port; other important ports on the Atlantic Coast are Boston, Portland, Me., and Philadelphia, Norfolk and Baltimore sometimes. With the opening of the Panama Canal, Portland, Oregon, Seattle and San Francisco have made direct shipments. In Canada, Halifax is the leading port, with other shipments from Montreal, St. John, N. B., and Quebec. Vancouver is a shipping port on the Pacific Coast.

Ports of import. For Great Britain leading import ports are Liverpool, London, Manchester (via Ship Canal), Glasgow, Hull, Southampton, Bristol, Cardiff. On the Continent the chief receiving points are Hamburg, Germany; Rotterdam in the Netherlands; Antwerp in Belgium; Havre in France; Bremen and Hamburg in Germany; Christiania, Copenhagen, and Gothenburg, Scandinavia.

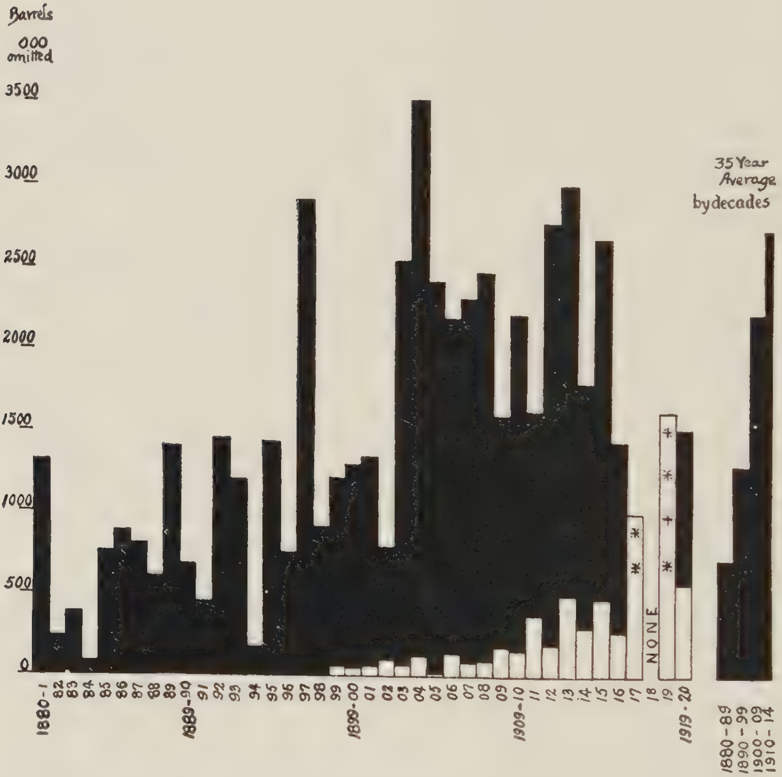
Volume of the movement. Under normal conditions the export movement has varied from 1,750,000 to over 5.000,000 barrels or its equivalent in 1923-24. Canada has exported as high as 1,600,000 barrels in a season and the United States over 3½ million barrels. Box apples have increased steadily so that they now constitute over a third of the total.

Market requirements. All markets demand honestly graded and properly packed fruit. Barreled apples must be firm, hard and preferably the original pack. Repacked or reconditioned apples rarely carry satisfactorily. The pack must be tight to insure good condition of the fruit on arrival and the barrel securely headlined. The key to success in exporting is a properly packed barrel. To insure success it must be properly racked—as each half bushel of fruit is placed in the barrel it should be gently settled in place and when full the follower should be used in settling the fruit thoroughly. The barrel may then be so filled that the head will touch all the apples on the end and yet when put in it will not smash any. A smashed apple is no better than a cavity. Over filling is as undesirable as slack filling, and a barrel which is not adequately racked will not carry. Boxes must be strapped. The European supply materially affects the volume shipped. England grows about half the apples she needs. These are largely green cooking apples, although some attempt is made to grow dessert apples as Cox Orange in the south of England and this industry is growing. When the English crop is short some early apples move from New England and the Hudson River section of New York in August and September. Sometimes Oldenburg is exported, but it is quite risky, Wealthy being regarded as the first export variety of importance. It is shipped as soon as it shows color. Gravenstein moves from California and other places. The movement from Nova Scotia may begin in October and is usually heavy until January, the principal varieties being Tompkins King, Ribston, Blenheim, Gravenstein and later

FIG. 74

EXPORTS OF APPLES FROM UNITED STATES AND CANADA 1880-1920 TO GREAT BRITAIN, GERMANY, SCANDINAVIA AND OTHER EUROPEAN PORTS. SHOWING TOTAL EXPORTS EXPRESSED IN BARRELS AND THE PROPORTION SHIPPED IN BOXES (3 BOXES=1 BARREL) IN WHITE AND THE AVERAGE FOR 35 YEARS BY DECADES.

Data from Reports of International Apple Shippers Association.



War restrictions affected exports 1915 to 1918 and the data is incomplete.

Roxbury Russet (Nonpareil) and Ben Davis. The barreled apple movement consists of such varieties as Baldwin, Rhode Island Greening, York Imperial, Gano, Ben Davis and Yellow Newtown. Such apples as Northern Spy and McIntosh require the utmost attention in packing and transportation to make certain of good condition on arrival. The box apples shipped are the varieties usually grown—Yellow Newtown from California, Hood River, Rogue River Valley, Jonathan, Esopus Spitzenburg, Rome Beauty, Ben Davis, Gano, Winesap and other red varieties are known on most markets, and the box apples of red varieties, of medium size, have made a good reputation in most markets. The arrival of Australian and Tasmanian apples in April on the British markets marks the closing days of the American export season.

Exporting. The Canadian apples move in boats subsidized by the Canadian Government. The growers with a short rail and then all-water route such as is enjoyed by Nova Scotia and some sections of New York and New England have a decided advantage. This advantage varies from 20 to 45 cents a barrel in so-called Eastern sections. An advantage of 25 cents a barrel, other things being equal, will locate a fruit industry. In addition the ability to reach the port in a few hours enables the handlers to hold their fruit in their own warehouses which is a decided advantage in itself.

American apples for export may be moved in three ways: (1) Shipments to be sold at auction on arrival. (2) Shipments on consignment to firms which may or may not be sold at auction. (3) Sales made f.o.b. to buyers representing English firms, some of which distribute through their own establishments by private sale or auction.

The mode of sale is either through the auction or by private sale. The auction system is in general use in Great Britain and is held to be the most efficient means of securing rapid distribution of a perishable commodity under the conditions usually existing in British ports. As the steamer discharges her cargo it is classified into "tights," "slacks," "wets" and "slightly wets" and the prospective buyers are on hand to take note of the marks on the barrels. The next day they appear at the auction room. Samples are taken from the dock to the store or auction room, and there displayed to the buyers by showing the faced end and/or by dumping the entire contents. The buyers occupy seats arranged on an incline so that all may see the fruit and the auctioneer. The fruit is rapidly sold. Private sales are conducted by firms who not only purchase direct but handle on consignment as well.

Must study British market. Generally speaking, it cannot be said that we are handling the British market as wisely as we might. With the movement of an uncertain quantity of box fruit from the Pacific Coast, much of which moves forward on consignment, the market is kept in a constant state of uncertainty. A period of limited supply is followed by an oversupply and a slump. This discourages the buying of fruit in this country. It causes loss to exporters and to those who have purchased the apples in England. Uncertainty and demoralization are the chief enemies to business. Profits are essential and confidence is a necessity for a profitable business. As a matter of self-preservation the exports should be made with more regard to the demand. It will be apparent that when an apple has been subjected to an inland rail movement here, to an ocean voyage during the roughest months of the year, to delays and rough handling, that the British are probably right in insisting that the only safe policy to pursue is to sell it as soon as possible after arrival, for whatever it will bring, and get it into consumption. Re-conditioning is not looked upon with favor nor is re-storage, although some of the exports from Hull to Scandinavian points are re-conditioned before being offered for sale in the country of consumption, but in these instances there seems to be no trade objection to repacked fruit.

Export grades might aid in developing the British market. If poor fruit and that which is not hard enough for export were excluded, this market could be developed so that it would be of much more value to the American grower and to the consumer as well as the exporter. Generally speaking, the packing has improved in the last year or two. It is generally believed that when the retail price exceeds 12 cents a pound the demand is curtailed. This represents the maximum price which can be expected and a free movement of supplies maintained.

Effect of the Panama Canal. When railroad rates were low there was no inducement to ship apples via the Panama Canal. With the advance in freight rates in 1920 trial export shipments were made to England with success. The first cargo of 32,000 boxes arrived in England with but 180 slightly broken boxes, at a cost of $1.40 a box for all charges. A second boat took 25,000 at a cost of $1.25 a box and landed the fruit in excellent condition. The apples were under refrigeration and reached destination in five weeks. The fruit was sold at auction upon arrival and deliveries were made throughout the United Kingdom within 24 hours by the railroads, which is a remarkable achievement. Other boats followed. The Royal Mail Steam Packet Company placed several 15,000-ton steamers with refrigerator space of 3,000 tons each in the service and the cost is being reduced. The movement reached a million boxes in 1923-24. Coastwise American steamers equipped with refrigeration now move not only apples but citrus fruit to our eastern seaboard, and an export trade is being developed with the West Indies. The Canal has also influenced imports. Fruits from Australia, Chile, Equador and other points reach eastern cities by this route.

CHAPTER XXVIII

DRIED FRUITS

Prunes, raisins, apples, peaches and apricots are all dried in relatively large amounts, and a number of other fruits to a lesser extent in the United States. California leads in the output of these products, frequently producing 80 per cent of the total, due to the excellent natural facilities for drying fruit. The drying of fruits by mechanical means is increasing. In many cases the work is performed by the grower in a relatively small way. This is particularly true of apples. Frequently a third or more of the apple crop is not of sufficient value to warrant shipment, but it is possible to reduce its bulk by drying and thus place it in fit condition for storage at little expense and for shipment when the market is ready. Seventy-five per cent of all the dried apples produced in this country come from western New York. The methods of drying now in use in this district have evolved during a series of years, and are a guide to those interested in this type of enterprise. The tower dryer with its rack and a thin layer of fruit and the oven or tunnel drier seen in the Pacific Northwest and used now in drying prunes failed to establish themselves in New York. The kiln type of drier is the one generally used.

Square kilns. Most of the fruit is dried in small kilns. These are small plants, operated by the individual owners of the orchards. They consist of the kiln floor, usually 16 feet to 20 feet square; alongside is the operating room, and below that the furnace room. There is in addition a small room for the storage of the fruit. This sort of kiln is inexpensive. In some cases an old building is made over to serve as a drying plant. No attempt is made to make the building fireproof. Usually it is of wooden construction. If there is a fire the whole is lost; no attempt is made to save it. It is from these small plants that some of the best dried fruit is secured. The larger plants are well built, some even fireproof in construction.

The unit type or one kiln tower is frequently erected on a side hill. The dryer is one-story high at the front and two in the rear. The apples are delivered at the front and in this way are upstairs when brought in. The basement is the furnace room. This size plant is commonly 16 feet by 32 feet, or 18 feet by 36 feet, or some such size, and is set on posts in the ground. The sill is a foot above the ground and the drying floor or kiln floor 11 feet high. On the ground floor in addition to the furnace room is the store or stock room. This connects with the drying floor by means of a chute, through and down which the finished fruit is shovelled as it comes off the floor. The reason for placing in this position is to get a certain amount of heat from the furnace. The fruit left in the storeroom must be turned every day for four or five days in order to get it thoroughly conditioned or seasoned. The storeroom in a small plant need not be large, since it is advisable to move out the fruit as soon as a ton is accumulated. On account of the risk from fire, no attempt is made to carry fruit for any lengthy period in these houses.

Construction of the kiln floor. The kiln floor may be 10 to 12 feet from the ground floor. Usually wooden joists are used and on these a hard-maple floor is nailed. The slats used are usually 1¼ inches wide on top and ½-inch wide on the bottom. The lower edge is placed down and the slats are laid one-quarter inch apart on the top edge. In case any small pieces of apple get between the boards they drop through.

The furnace. The furnace used in a unit plant usually is 6 feet high with a fire pot 36 inches in diameter. The cost ranges from $40 to $50. A grate 3 feet in diameter, containing 5 to 7 square feet, is sufficient to heat a kiln 20 feet square. This is usually set in the center of the room. The most common method is to use a 10-inch pipe to radiate the heat. The pipes are hung about 3 feet below the kiln floor. In some instances, they are run back and forth 2 to 3 feet apart under the entire floor of the kiln, requiring some 200 feet of pipe. This gives more uniform drying on the floor itself. In other kilns two to four pipes are passed from the furnace in two sections; the pipes are run in opposite directions, following the wall at a distance of 2 or 3 feet from it and connecting at the chimney. Where the heat is intense immediately over the furnace, causing the fruit to dry too fast in the center of the floor, a reflector is used. This is made of sheet tin or iron several feet square, and is attached to the floor directly above the furnace.

The air intake. It is important to have a furnace of sufficient size. Cold air drafts are usually placed on each side of the furnace room as near the ground as possible. These furnish the air for the furnace and enable the heated air laden with moisture to pass from the apples through the tower above. The flues admitting air to the furnace room should be 10 per cent of the floor space. The tower furnishes the ventilator and the opening should be 15 per cent of the floor space.

Paring tables. There is a single long table on which the paring machines are fastened and on the opposite side is an individual table, one for each parer. In some cases, an endless belt passes in front of the parers to carry the apples without further handling. One of these is not possible in a small plant such as is usually found on a farm. The paring machine may be driven by hand or power. A small plant operating 60 to 100 bushels a day would require three handpower machines; one would probably be in operation all the time and the other two but part of the time, care being taken to get the fruit into the bleacher as rapidly as possible after it is pared so as not to become discolored.

The hand-trimming machines cost $10 to $22 each and the hand-slicing machines $15 to $30. Power machines will cost $40, the power-slicing machines up to $125. A machine of the latter type will handle 800 to 1,000 bushels a day. Two good trimmers are needed to look after the fruit from a continuously operated machine. Sixty bushels per day is a satisfactory output for one machine if the fruit is of fair size. A power paring machine may do 15 bushels more.

The bleacher. In large plants the bleacher consists of a box under which sulphur is burned so that the fumes pass through all the time. It is equipped with a slowly moving slat floor on which the fruit is dropped. It is so arranged that by the time the fruit has gone the whole distance it is adequately bleached. In a small plant the bleacher usually consists of a box probably 5 feet square in which there is a slat floor; the box is divided into two compartments so that one side can be used while the other is being filled. The outer edge of this slat floor is just high enough to admit a bushel crate. The floor is sloped to move the apples out of it with ease.

In some small plants the paring table is about 3 feet wide and 5 or 6 feet long and is set up about 15 inches high so that the fruit as trimmed may run by gravity down a chute into the bleacher at the end of the table. In other plants it may be led into the bleacher by means of a spout. The bleaching is done by burning sulphur and it is to this operation that most of the fires are due. A metal basin of a pint capacity is sufficient for a bleacher of the size given. Each half of the box is connected with the chimney by a pipe 6 or 7 inches in diameter to carry off the fumes. The whole fruit may be run into the bleacher and allowed to remain there from 45 to 60 minutes, depending upon its maturity. Naturally the bleacher in which the fruit is moved on a tray elevator or on a slowly moving floor involves the least handling. Where plants are equipped in this way the fruit is moved direct from the bleacher onto the slicer. Some machines are equipped with feeders that work automatically. From the slicer the fruit drops into a barrel and is carried and spread on the kiln floor. The apples are cored while being pared and are sliced so that the core opening is in the center of the slice thus making rings.

Loading the kiln floor. In a small plant the kiln is loaded but once a day. Fruit is stored in barrels until the charge is removed from it, which may be done probably by three o'clock in the afternoon. In large plants where there are several compartments or kilns, one is being loaded all the time. The fruit is spread 4 to 6 inches deep and is dried in from 10 to 14 hours. In the small plant, however, operated by five or six people, the kiln is loaded by five or six o'clock at night when work ceases; a good fire is made and maintained until nine o'clock. Some operators prefer a temperature of 150° F. when the fruit is put on the floor, which may be allowed to fall to 125° F. as drying nears completion. A kiln 20 feet square will hold the slices of 120 to 150 bushels of fresh fruit. If the fruit is well dried for three hours the furnace is then banked until early in the morning when the fruit is turned; it is turned twice more before noon, the turning being done every two hours. It is ready to take off by two or three o'clock that day.

Turning the fruit. In turning, a wide snow shovel is used. The fruit is thoroughly turned over, none is left attached to the floor. It may take half an hour to turn the kiln. In the large plants the fruit may be turned in two or three hours after it begins to dry; then every two hours thereafter, the aim being to get it off as rapidly as possible. If too much heat is given the rings may stick to each other or to the floor.

Yield of dried apples per bushel. Apples vary greatly in weight per bushel. A bushel of Smith Cider may average 38 pounds, York 50 pounds and Mann over 50 pounds, but a bushel of good Baldwins should make 6½ pounds of dried fruit and 3½ pounds of waste. If the fruit is dried whole without slicing it will make one to two pounds more to the bushel than when sliced. About one-third as much space is required for drying the parings and trimmings as is necessary for the white fruit. The waste consists of skins and cores and the chops. Small apples which are too small to pare and which are merely chopped up or cut in squares are usually not passed through the bleachers, but may be bleached by burning sulphur in the furnace room after the stock has been spread on the floor. It is usually hoped that the waste will pay the coal bill. A pound of hard coal is usually required to dry a pound of fruit. In the ordinary kiln the use of soft coal is not desirable because of soot. Oil burners are on trial.

Care of the floors. The floors are scrubbed from time to time, using any ordinary scouring soap. Sometimes a mixture of boiled linseed oil and tallow is used, although some operators contend this mixture discolors the fruit.

When is the fruit dried? The appearance of the fruit will largely determine. It is largely a matter of judgment. If a handful is pressed together firmly and the slices separate at once upon being released, it is held to be dried. It should not be possible to press any free juice into view if a ring is broken. The fruit should be soft and velvety and somewhat leathery in texture. Probably some of the rings will be over dried, others not sufficiently dried; by holding them for a few days in the curing room the tendency is to equalize the moisture content.

The moisture content. At the present time the Federal law demands that apples shall not contain more than 24 per cent of moisture. The moisture content formerly established in New York was 27 per cent, but such apples will not keep well in a store, hence the reduction. With this present standard a little less dried fruit is made from a bushel of apples than formerly.

Some of the points to watch are: (1) The character of the fruit which is used. Today the fruit is frequently run over graders to get rid of the small apples so that the product will be more uniform. (2) Fruit which is bruised or is decaying is extremely wasteful both of time and in the output. (3) Some apples dry better than others; Ben Davis makes very good white stock; Baldwin is much used. (4) Most early apples are not sufficiently firm in texture to give good results; drying usually does not begin until the winter fruit is ready. (5) In buildings which are not very substantially built there is difficulty in maintaining the draft on windy days. (6) In some cases drying by steam heat is used, but this is possible only in large plants. It is contended that steam drying is more economical in fuel, but a man is required to watch the boiler most of the time, which is possible only in a large plant. (7) Where apples are quartered or dried whole, considerably more fuel is required than when they are sliced, frequently 25 to 50 per cent more. (8) The fruit may be sliced at the time it is pared, or it may be bleached first. (9) In the trimming it is important that no small pieces of skin or decayed spots be left on the fruit. (10) The knife used is usually a straight back pointed one with a blade 2½ to 3 inches long.

Bleaching. The object of bleaching with sulphur is to please the eye. The public prefers white fruit or bleached fruit to brown fruit which is not bleached. If it is found that the fruit is not retaining its white color after it is dried it must either be left in the bleacher a little longer or more sulphur must be burned in a given time. The length of time the fruit is kept in the bleacher varies from 20 minutes to 1½ hours. The amount of sulphur used to bleach a ton of fruit is 4 to 20 pounds. It is always desirable to get the fruit into the bleacher as soon as possible after it is pared.

Slicing. The slices are rings, usually one-quarter of an inch in thickness. The larger the percentage of rings in the sample the higher the grade of the fruit, other things being equal.

Stock for dried apples. Certain apples—Baldwin, Ben Davis, Gravenstein, Spitzenburg and Winesap—give "white stock," which is desirable for small cartons for fancy grocery trade. Dark stock apples are Black Twig, Delicious, Gano, Grimes, Jonathan, Newtown, Rhode Island Greening, Rome, the Russets, Stayman and Wagener. These contain a higher sugar content and give a slightly higher yield of dry product. The central and western dryers tend to dry to a less moisture content than New York. The averages are given in the following table, showing yield and average moisture content of certain dried fruits:

YIELD OF DRIED FRUIT AND MOISTURE IN IT

Kind of fruit	Yield per ton in pounds	Percentage of moisture in product
Apples, white stock	240-250	24
Apples, dark stock	250-275	24
Apricots, halves	350-400	26
Peaches	225-250	22
Pears, quarters	270-300	24
Cherries	400-450	24
Blackberries	380-400	18
Raspberries, black	440-475	18
Raspberries, red and purple	400	18
Loganberries	340-370	18-20
Prunes	600-675	22

Grades. Three grades are usually found in commerce—fancy, choice and prime. Fancy is very white, clean stock with no pieces of skin attached and a large proportion of the slices in rings. Choice is not quite good enough for fancy but is better than prime. Prime is good stock, well cured, comparatively white but containing a small percentage of defects. Another grade is sometimes made, called extra fancy, in which 85 per cent of the slices are rings. Anything which falls below prime is practically junk.

Expenses. In the small plants in Western New York the cost of drying previous to 1916 usually reached 12 to 13 cents a bushel, the fruit costing 17 to 20 cents a bushel, so that the cost when dried was about 33 cents. With an average production of 6½ pounds at 6 cents a pound the fruit returned 39 cents. In addition, there were perhaps 4 pounds of waste worth 4 to 6 cents, making a total of 45 cents per bushel of apples. With slightly higher prices (a quarter of a cent a pound is quite an item) the returns from a bushel of fruit might reach 50 cents. In such a case the returns to the proprietor would be 17 cents to pay his own expenses and meet the risk. The advance in all costs since 1916 have been so variable that no average costs can be given. It will take experienced help to maintain this return and the aim should be to locate so that the plant can operate for three months. In many cases the plants are operated only once in two or three years and then for short periods only, perhaps for six weeks; but even so, many fruitgrowers feel that it is advantageous to have a dryer on the farm that they may convert the fruit into a form in which it can be held for two years or three if necessary. If the proposed Federal cold storage legislation be enacted, forbidding the storage of any food commodity for more than twelve months, the drying of apples might be seriously affected.

Evaporators are erected by the vinegar factories for the purpose of drying the pomace and at the canneries for the purpose of drying the skins and cores from canned fruit. It has been found that the skins and cores are much more valuable for jelly-making than the apple itself.

Packages. The fruit drier seldom markets his product direct to consumers. Dried fruit is usually sold to a broker or jobber who packs and grades according to the trade he expects to supply. Fancy apples, when used, are put in fifty-pound boxes or they may be put up in cartons. The waste and chops are usually sold in bags holding 100 pounds, or put into barrels containing 240 to 250 pounds. Fruit held over is placed in cold storage at a temperature of from 32 to 35° F. It may be kept four or five years. Considerable damage has been done to the industry by drying immature fruit. Good dried apples cannot be made from immature fruit.

Raisins and prunes. The drying of apples is insignificant in amount compared with prunes and raisins. Raisins are usually sun-dried, as are also prunes in California. In Oregon, where conditions are not so favorable, the prune is dried in ovens on trays. These are fed in at one end of the oven and slowly pass along, meeting the highest temperature at the beginning of the period and a cooler temperature as they pass along, at last reaching the dry state.

Dried peaches and pears. The drying of peaches has not been pushed in the East, although it is carried on on the Pacific Coast. The drying of pears commercially is not practiced in the East; they are used for canning only. Peaches are both dried and canned in California. Black raspberries are dried in New York. The kilns used for drying apples in New York are also used for drying vegetables such as carrots, cabbage and beets. If drying plants could be operated for a longer period of time, much would be added to the stability of the dried fruit and vegetable industry.

The dehydrator. Much thought has been given to the problem of dehydration. Eventually some better scheme will be evolved than what now prevails. One interesting system which aimed to standardize the business by substituting definite conditions and definite rules instead of rule-of-thumb ideas was put out under the name of the ''dehydrating system.'' Fruits and vegetables are placed on trays in a chamber, the air before it is admitted to the chamber is passed through a freezer to free it from moisture and is then heated to a temperature of 135° F., at which point it is passed over the fruit rapidly, to take the moisture from it. The passage over the fruit is accelerated by an outlet fan which revolves faster than the intake fan. In this way apples are dried in an hour instead of ten hours. It is believed that the saving in time tends to retain more of the fruit flavors which are now lost to a degree in drying. Such a plant may be used for any fruit, fish, vegetable, meat or for any product which needs drying. Dehydration, eventually, will give to producers an inexpensive method for the preservation of all perishable products of the farm so that in winter there will be available near-to-fresh products at small cost. Even in California dehydration is growing in favor because of the better average quality of the products, the greater average yield, the lower cost and the protection assured against rain damage losses.

CHAPTER XXIX

JUDGING FRUIT

Different sections of the country have different requirements for judging fruit, but there is a marked tendency on the part of judges to accept the rules laid down by the American Pomological Society. These rules should govern and those wishing to exhibit should give them careful study and conform to them.

Arrangement. Whenever fruit is staged in displays, a certain amount of consideration is given to the arrangement. In this, of course, the judge must be allowed a certain amount of latitude, but the points considered are the taste and skill displayed, due weight being given to anything which stands out prominently and arrests attention, especially when it is pleasing in effect and is important.

Commercial exhibits. The commercial character of the package, as well as of the fruit is considered. A regular score card has been devised, considering all points. In plate displays, opportunity is often given for a systematic classification or grouping of varieties. For instance, by seasons or by uses and season; whether the fruit is for dessert, culinary purposes or baking, or for general market purposes. When it comes to individual fruits all points enter into the making of a good sample. Many of these are of decided commercial value, as the following:

Color. The color of the variety should be bright, clear, well developed and characteristic of the variety. In red apples, color constitutes fully 70 per cent of the sale value. A well-colored sample always sells ahead of a poorly colored sample. If it were not so the best colored apples would not be sorted out and placed on the face of the barrel.

Form. A roundish apple is the most desirable form. The oblong or oblate apple, or one which has bumps on the calyx end is rather at a discount because these protuberances are easily injured and are a detriment to the variety rather than a help. The commercial man knows that the roundish apple stands the most abuse and they favor it.

Freedom from blemishes. Any injury, whether caused by insects, diseases, loss of stem or by any other cause, lessens the value of the exhibit. The apple so affected is blemished. Today, even in commercial packs in the highest grades, apples showing injury by insects or diseases are not allowed; nor are those which show bruises other than those incidental to the work of packing.

Polish. Fruit may be shown polished or not. At one time polishing was forbidden. In many cases the natural bloom on a variety such as on Northern Spy and McIntosh is esteemed to be of greater value on the apple than a polished surface.

Quality and texture. In national displays, where fruits from a large area are brought into competition, quality and texture are taken into consideration, even within the variety, and these factors are always considered in judging collections or seedlings or new varieties. On the market, however, they are of less importance than color, and yet they receive more consideration as time goes on. The best illustration is the fact that Ben Davis has been discounted more in recent years than ever before, although it still occupies a very important place.

Size. In exhibits and in commercial work, size is important. There is a desirable size for each variety and the apple should be of good size for the variety. It is not always the largest apples that are best or that will sell for the most money. The baked-apple trade wants a very large apple. The hotel trade does not want too large an apple for dessert purposes. There is a growing tendency to use nothing above medium size for exhibit in dessert classes unless a premium is given for large-sized specimens. While size is a most important commercial factor, it may be of less importance than high color and freedom from blemishes. Today, fruits may be too large to win; and in plate exhibits, a plate of equal excellence but of somewhat smaller size may be considered superior to the larger sized fruits.

Uniformity. Even barreled grades are coming to be sized to one-quarter inch. Hence all apples sizing 2¾ to 3 inches are placed into one barrel, and 2½ to 2¾ inches, 2¼ to 2½ and 2 inches, all into their respective barrels. Some places still ask that the small apples, those 2 to 2½ inches, be packed in one barrel and the 2½ inches and up be packed in another, making but two sizes of the crop. It depends upon the class of trade. In all exhibits, the apples should be as nearly alike in size and in all other respects as is possible. Both in exhibits and commercially, uniformity as to color is wanted. Apples not uniformly or adequately colored are placed in a lower grade.

Season. In making a display of collections it is important to represent as long a season as possible. In order to do so it is not wise to show varieties out of condition, for such will be scored and judged upon the appearance of each apple at the time. If the variety is out of season and out of condition at the time it may be better not to exhibit that variety. The same applies equally as to the time of movement. Varieties should be moved while in season.

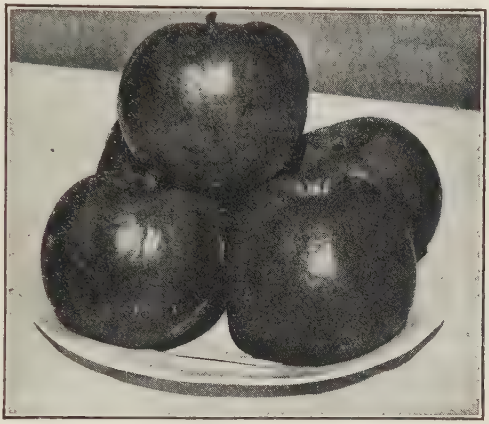


FIG. 75. Rhode Island Greening Apples. The first prize plate in a class of 65 entries at N. Y. State Fair, showing uniformity.
Grown by the Author.

Nomenclature. Every package of fruit must be correctly named, and each exhibit must be correctly labelled. The names adopted by the American Pomological Society are standard. A barrel of apples incorrectly named is misbranded. Names mean something. Incorrect naming is not tolerated in commercial lines, much less so in an exhibit.

Commercial value. Standard and known varieties and those which grow and are best suited to the locality in which the exhibit is held, always have the preference. They should be given more weight in a large display than varieties which are not of commercial value.

CHAPTER XXX

DWARF TREES

A dwarf tree is one which has been forced to remain smaller than it normally would or which is inherently dwarf in stature. Trees may be dwarfed: (a) By growing them on a root which is normally a dwarf in size; (b) by checking the growth of the root and (c) by checking the growth of the top. We see factors (b) and (c) carried to an extreme in some plants in Japanese gardens, but for general purposes in horticulture usually a dwarf tree is understood to be one that has been grown on a stock which stunts or restricts its size. We may use all three factors with some plants. A dwarfing stock is a smaller, weaker or slower growing tree than the variety propagated on it. The top is dwarfed. Budding is preferred in working dwarf stocks.

Stocks for apples. Commercially speaking, the Paradise or French Paradise of the British, is the stock used for producing very small trees, those 8 to 10 feet as an average height. The Doucin or English Paradise is used for producing semi-dwarf trees, with 20 feet as the average height. The word Paradise is a poor term to use. It is applied to any stock that is propagated by layering or from stools—vegetative multiplication; while a "free" stock is one raised from seed or by seedage. Paradise stocks as purchased will produce seedling trees of all sizes, from the smallest dwarfs to trees equal to any standard. It does not necessarily mean a dwarf stock. Dwarf stocks then must be secured by multiplying vegetatively a plant which has been previously determined to be of dwarf habits.

Some Paradise stocks are more subject to cankers than others. Some are much more dwarf than others. The whole problem of stocks is badly mixed; and the grower may have difficulty in securing what he wants. The most dwarf stocks are the ones desired for cordons, espaliers and trees to be grown to a fancy form.

Stocks for cherries. The Mahaleb stock dwarfs the cherry to some extent, but the Sand Cherries (*Prunus pumila and Prunus besseyi*) are the most promising stocks for dwarfing this fruit.

Peaches, apricots and nectarines are usually dwarfed by working them on plum stocks, the Damson or the St. Julien stocks being the most promising. These will unite with the sand cherries, but the duration of the union is not known. The sand cherries would give a dwarf tree suitable for pot work.

Stocks for plum. The Damson or St. Julien stock has been used in the past, but stocks for plums have not been thoroughly tested. The sand cherries are well worthy of trial, since many of the European and Japanese plums have already shown that they will make satisfactory unions with these stocks.

Stocks for citrus fruits. Oranges, lemons, grapefruit, etc., may be dwarfed by budding them on the Trifoliate orange (*Poncirus trifoliata*). The stocks show considerable variation, some are congenial others not.

Quinces as pear stocks. The quince is a bush, but there is considerable variation in the seedlings furnished the nurseryman. These include several types. As many as six distinct types have been recognized in the seedlings usually sent out under the name of Angers quince. The quince is used to dwarf pears.

The place for dwarf trees. The dwarf is not usually a commercial proposition, but is desirable for the amateur. Most dwarf trees are shorter lived than standards. They need more care than standards—in pruning, tillage and fertilization. Dwarf trees are more costly to grow in the nursery. Dwarf trees of the varieties desired are difficult to secure, since there has not been sufficient call for them to warrant nurserymen to grow them in a commercial way.

For the amateur. The dwarf tree is easier to prune than a standard tree, is easier to spray, easier to thin the fruit, easier to harvest the fruit. Its use enables one to grow high-class varieties which cannot be easily purchased and to secure fine specimens. Owing to the small area required, one can grow a large number of varieties in a relatively small area.

Training. Dwarf trees may be trained in various shapes. The most common manner of training in Europe is the cordon, which may consist of single stems allowed to grow upright, obliquely or horizontally. Sometimes one and sometimes two arms are permitted. Again the trees may be trained with two or more stems, "U" shaped or "UU" shaped. Sometimes a central trunk is developed and from this horizontal arms are developed at perhaps 8- or 10-inch intervals, or the tree may be trained in fan shape or allowed to make a pyramid. If space is limited and a wall is available, facing preferably east, west or north, it may be covered with trained fruit trees. It is best to fasten the trees to wires, rather than directly to the wall. Posts should be driven firmly as for grapes, or iron posts may be used. Wires may be stretched and the trees trained to these. Wooden fences also may be covered in this way. All such trellises or espalier fences should be well made. Yearling trees are best unless they have already been trained. If a beginner wishes to train the trees himself, nothing older than a year should be purchased.

Training suggestions. Prune strong branches severely; weak ones lightly. Depress strong branches, elevate weak ones. Suppress useless buds on strong parts early; on weak parts delay suppression. Fasten strong parts to the wall or trellis early; delay doing so to weak parts. Permit as much fruit as possible on strong parts; remove all on weak parts. Keep strong parts close to the wall, bring weak parts forward. Deprive strong parts of light by covering. In winter pruning, leave no more branches than are required for the development of the tree and the formation of fruit-bearing branches. Repeatedly pinch off summer shoots that are not required for the development of the tree.

Pot plants. Most citrus fruits, as well as apples budded on French Paradise apple roots, peaches on plum roots, pears on quince roots, etc., may be grown in pots or tubs. Small or medium size plants, as they grow in the nursery, should be selected. The fig and the kumquat make excellent potted plants. Oranges may be grown on Japanese orange (*Poncirus trifoliata*) roots. The Otaheite is frequently used purely for ornamental purposes. Attention to the following points is important:

1. Give adequate drainage, using 2 or 3 inches of broken crockery in the bottom of the tub and leave a hole or two in the tub.

2. Make the soil suitable by mixing one-fourth sandy loam, one-fourth leaf mold, one-fourth good loam and one-fourth rotted cow manure.

3. Keep the plant fed when the soil approaches depletion, either by liquid manure, cow manure or hen manure soaked in a barrel. Apply or add new rich soil to the pot.

4. Re-pot when the plants get root-bound.

5. Give the plants a dormant period each year.

6. Seedlings of oranges, lemons, grapefruit, etc., may be grown at home and budded to good varieties of citrus fruits.

7. Heading in and renewal of the branches may be done every five or six years to keep the plant within bounds, healthy and to produce new wood.

8. Small, weak branches may be removed any time they are not needed.

9. Washing or spraying the plant from time to time with fish oil soap will remove the scale insects that are apt to infest the leaves.

Suitable varieties for pots. Apples—Wagener, Early Joe, Bailey Sweet, Wealthy, Chenango, Primate, Jonathan, Spitzenburg, Canada Red, Yellow Transparent, Williams, Melon, McIntosh. Wealthy and Wagener both withstand heading back quite well.

Pears—Bartlett, Seckel, Sheldon, Elizabeth, Lucy Duke, Glou Morceau, Nantais, Dana Hovey, Bosc, etc. Some and probably all should be double-worked to secure a satisfactory union. Beurré Hardy is proving to be one of the best varieties to top bud on in certain regions. Another list includes Souvenir du Congrès, Madame Treyve, Fondante D'Automne, Louis Bonne, Conference, Magnet, Pitmaston Duchess, Durondean, Princess.

Sweet Oranges—Majorca, Jaffa, Pineapple, Centennial, Ruby, Maltese Blood and Tardiff.

Mandarins—Satsuma, Dancy and China.

Pomelo—Marsh, Duncan, Hall, Pernambuco and Royal.

Lemons—Villafranca and Genoa.

Limes—Tahiti, Mexican and Rangpur.

Kumquats—Marumi and Nagami.

Figs—Brown Turkey, Negro Largo, White Marseilles and Violet Sepor.

Plums—English lists include: The Czar, Blue Rock, Greengage, Grand Duke, Denniston Superb, Early Transparent, Golden Esperin and Belgian Purple. Probably such varieties as Tragedy, Imperial Epineuse, Millers Superb, Peters, Reine Claude, Sannois, Middleburg and other high quality plums should be tried.

Peaches—If grown under glass, English lists include: Early —Duchess of Cornwall and Peregrine; middle—Bellegarde, and late, Late Crawford, Thomas Rivers and Princess of Wales. For our conditions a variety like Champion should be considered and the highest quality American varieties tested.

Nectarines—Early: Cardinal, Early Rivers, Lord Napier and Advance; mid-season, Stanwick Elruge, Rivers Orange, Chaucer; and late, Victoria, Newton, Humboldt and Spencer.

There is an excellent opening for American amateurs to develop a full line of high quality fruits suitable for the home garden, greenhouse and pot culture.

CHAPTER XXXI

APPLE COSTS, YIELDS AND PRICES

Average costs of 1,000 orchards. In the Northwestern states, data collected during a period of four years, 1911 to 1915, from 1,000 men in Oregon, Washington, Idaho and British Columbia, who had at least two-thirds of their farms devoted to orchards and two-thirds of their orchards to apples, when summarized, showed the following facts: The average cost of cleaning land and planting apples was $112.82 per acre. The average annual cost of maintenance and development in the orchards two to three years of age was $62.72 per acre; from four to five years $60.36 per acre; and from six to seven years, less receipts, was $42.87 per acre. The average annual cost of production in orchards six to nine years old, with an average yield of 120 bushels per acre were for maintenance, $30.71; overhead, $57.03; handling, $53.18, a total of $140.92. Stated by the box the figures are: Maintenance, $0.2564; overhead, $0.4776, and handling, $0.4463, a total of $1.1803. The average cost in orchards ten to eighteen years of age, with an average yield of 233 boxes per acre, was as follows: for maintenance, $40.75; overhead, $110.76, and handling, $68.99, a total of $220.50. Stated by the box, the figures are: For Maintenance, $0.1782; overhead, $0.4737, and handling, $0.3030, a total of 95½ cents.

The costs of a box of apples in 1918-1920 showed about 45 to 50 per cent increase over those of 1911-15. The increase was at least 50 per cent in labor and 50 to 100 per cent in the price of supplies, with 100 to 200 per cent in tools and certain other articles as paper, etc.

Cost factors. The factors considered in arriving at the annual cost of apple production are: (1) Labor for maintenance; manuring, fertilizing, pruning, disposal of brush, plowing, other cultivation, thinning, propping, spraying, miscellaneous, cover crop and irrigating where practiced; (2) labor in handling; hauling, picking, sorting, packing, hauling to station and cull labor; (3) materials used: barrels or boxes, spray material, manure, fertilizer, gasoline and oil, cover crop seed; (4) and fixed charges or overhead; taxes, insurance, equipment charge, machine hire, interest, building charge and water rent where used.

Costs in Hood River. In the Hood River Valley, detail study made in 1915 of the current costs of handling the orchards on fifty-four farms showed that the average cost of labor where clean cultivation was practiced was $43.63 per acre and $35.41 per acre where the orchards were mulched. The cost of handling, picking and packing—all the cost incident to harvesting—where clean cultivation was practiced, was $49.46, and where the crops were grown under mulch, $51.18. After making allowance for the culls, it was found that the cost per acre for all labor where clean cultivation was practiced, was $87.78, or $0.4026 per box; where mulching was practiced, $81.68 per acre, or $0.3583 per box. The total number of man-hours used on the thirty orchards given clean cultivation up to the time of harvesting was 133.75, and horse-hours, 90.28 per acre. In the twenty-four mulch-crop orchards, 152.75 man hours and 70.82 horse hours per acre were required for annual maintenance. In the aggregate, this is 47 per cent of all labor cost, and 17.6 per cent of the total cost of production. The costs other than labor are summed up in the table following:

Costs of Producing Apples in 54 Orchards, Hood River, (1915)

	Clean-culture. 30 records; yield, 218 boxes			Mulch-crop. 24 records; yield, 228 boxes			All records. 54 records; yield, 222 boxes		
	Cost per acre	Cost per box	Per cent of total cost	Cost per acre	Cost per box	Per cent of total cost	Cost per acre	Cost per box	Per cent of total cost
Net cost of labor prior to harvest	$43.63	$0.2001	19.58	$35.41	$0.1554	15.24	$39.97	$0.1801	17.61
Net cost of labor for harvesting	44.15	.2025	19.81	46.27	.2029	19.91	45.08	.2031	19.86
Net cost of all labor	87.78	.4026	39.39	81.68	.3583	35.15	85.05	.3832	37.47
Material cost	41.12	.1886	18.45	45.06	.1976	19.40	42.80	.1927	18.86
Fixed cost	93.93	.4309	42.16	105.58	.4632	45.45	99.11	.4458	43.67
Material and fixed costs	135.05	.6195	60.61	150.64	.6608	64.85	141.91	.6385	62.53
Total cost	222.83	1.0221	100	232.32	1.0191	100	226.96	1.0217	100

The interest on investment is the largest item entering into the cost of production. It constitutes 34.9 per cent of the total annual cost of production on the farms studied. This cost is figured on an average investment of $990 per acre, at 8 per cent, the total investment per farm being $23,487. The fifty-four farms averaged 39.45 acres, with 69 per cent of the land tillable. The orchards averaged 12.4 acres in size. They were twelve years of age and had seventy-two trees to the acre. The apple orchards constituted 32 per cent of the total farm acreage, Yellow Newtown and Esopus Spitzenburg being the varieties grown almost exclusively. The average yield per acre was 222 boxes, at a cost of $1.02 per box. The interest charged per acre is $79.26 and the charge per box is $0.3507. Other items which go into the fixed cost are: Water rent which amounted to $2.62 per acre for those who irrigated and averaged $1.56 per acre, or $0.07 per box; the average annual tax was $8.19 per acre, or $0.036 per box; the orchard's share of fire insurance was 33 cents per acre or $0.0015 per box; the building charge amounted to $3.27 per acre or $0.014 per box, and the equipment charge was $6.50 per acre, being made up of depreciation, upkeep, interest and taxes on the equipment, or $0.029 per box, practically 3 cents. Fixed charges comprised 43.67 per cent of the total annual cost of production.

Apart from fixed charges and labor is the cost of materials. Materials include such items as manure, spray materials, seed, boxes, nails, paper, etc. The average price per ton for manure was $1.50, the average amount applied annually per acre was 1.48 tons at a yearly cost of $2.22 per acre or 1 cent a box; spray materials at prices then paid, $6.50 per barrel for lime sulphur, 7 cents a pound for arsenate of lead paste, 1 cent a pound for lime, 7½ cents a pound for copper sulphate, 17½ cents a pound for dry arsenate of lead, 18 cents a pound for alfalfa seed, 20 cents a pound for clover seed, 9½ cents for box shooks or 10.3 cents for boxes made up (the usual contract price for making up being 80 cents per hundred), paper and nails, 3.9 cents a box—total cost of a finished box including paper and nails, 14.2 cents a box. On the farms studied the total material cost amounted to $42.80 per acre, or 19.2 cents per box. This was 18.86 per cent of the total annual cost of production.

Size of orchard to total cost. It is generally true that the larger the yield the higher the cost per acre, but the lower the cost per box. Orchards yielding 440 boxes per acre had a cost of $304.66 or 69.1 cents a box, while in another extreme where there was a yield of 115 boxes per acre, the cost per acre was

$180.51, or $1.57 per box. This is brought out in more detail below:

RELATION OF YIELD TO TOTAL ANNUAL COST OF PRODUCTION (54 FARMS), HOOD RIVER

Yield (in boxes)	Average yield (in boxes)	Costs										Number of records
		Maintenance		Handling		Material		Fixed		Total		
		Acre	Box	Acre	Box	Acre	Box	Acre	Box	Acre	Box	
150 and under	115	$36.33	$0.3168	$23.62	$0.2054	$24.64	$0.2143	$95.92	$0.8341	$180.51	$1.5706	11
151 to 200...	177.6	34.63	.1950	35.37	.1992	34.23	.1927	96.45	.5431	200.68	1.1300	10
201 to 250...	219.6	37.01	.1685	40.73	.1855	43.81	.1995	105.08	.4785	226.63	1.0320	17
251 to 300...	270	45.05	.1669	59.80	.2215	51.97	.1925	101.12	.3745	257.94	.9554	7
301 to 400...	335.2	53.88	.1607	74.37	.2219	60.36	.1801	93.66	.2794	282.27	.8421	6
Over 400 ...	440.8	48.26	.1095	88.08	.1998	76.32	.1731	92	.2087	304.66	.6911	3
All records.	222	39.97	.1801	45.08	.2031	42.80	.1927	99.11	.4458	226.96	1.0217	54

The higher yields were generally found on the small orchards. This is shown below:

RELATION OF SIZE OF ORCHARDS TO TOTAL COST (54 FARMS), HOOD RIVER

	Cost of production in orchards of each specified size							
	5 acres and under (280-box yield, 4 records)		6 to 10 acres (228-box yield, 25 records)		11 to 20 acres (211-box yield, 19 records)		Over 20 acres (196-box yield, 6 records)	
	Per acre	Per box	Per acre	Per box	Per acre	Per box	Per acre	Per box
Maintenance...........	$63.26	$0.2252	$40.38	$0.1773	$35.77	$0.1695	$36.13	$0.1839
Handling..............	56.14	.1999	47.03	.2066	42.89	.2033	36.67	.1866
Labor cost............	119.40	.4251	87.41	.3839	78.66	.3728	72.80	.3705
Material cost.........	53.94	.1920	43.60	.1915	41.15	.1950	37.68	.1918
Fixed cost............	102.36	.3644	98.27	.4316	100.92	.4783	94.68	.4818
Material and fixed cost.	156.30	.5564	141.87	.6231	142.07	.6733	132.36	.6736
Total cost...........	275.70	.9815	229.28	1.0070	220.73	1.0461	205.16	1.0441

In Wenatchee, taking 87 orchards in 1914, the average investment per farm was $20,974, the average size being 11.4 acres. The average investment of these farms per acre was $2,026; the average size of bearing orchard, 6½ acres; value per acre of apple-bearing orchard, $1,925; equipment investment, $440 per farm or an average of $47 per acre, excluding live stock. The farms average two horses, or 5.3 tillable acres per horse. Total annual cost of production was $469.73 per acre or 79.2 cents per box f.o.b. Of this, the labor cost was $179.09 per acre or 30.2 cents a box. Fixed cost, including interest on investment was $290.64 per acre or 49 cents a box. The trees averaged eleven years of age, 81 trees to the acre. There were many varieties, chiefly Winesap, Jonathan, Esopus Spitzenburg, Rome, Stayman, Gano, Ben Davis, Newtown and Arkansas.

In these orchards the yield per acre was 593 boxes, or 7.3 per tree, which is high and has not been maintained. This represented all the yield on trees from seven to eleven years old, inclusive. No charge was made for depreciation, but it is assumed that these orchards will bear for thirty years. This would involve an additional item of $64.17 per acre or 10.82 cents a box. Some believe this is too high, and that 4 to 8 cents is nearer the right charge. This would bring the cost per box 84 to 89 cents. Orchards in mulch cost about 2 cents per box less. If we exclude the item of investment, about 33 per cent of the total, which the average orchardist does not calculate, the cost of production on the farms studied would be about 50 cents per box, without any charge for depreciation of the orchard.

Studies in Western Colorado. On 125 farms studied in 1914 and 1915 there was shown an average cost of 84.4 cents per box for the entire region. The trees in the orchards studied averaged seventeen years of age and were 74 to the acre. Jonathan was the leading variety with Ben Davis, Rome, Gano and Winesap following. The average yield for the district was 284 boxes per acre, 3.8 boxes per tree. The average investment per farm was $16,366; average bearing apple orchard was 8.22 acres and constituted 42 per cent of the average farm area. Average investment per acre being $751.56. The summary of all costs in the three districts, Mesa, Delta and Montrose is given below:

Summary of all Costs Entering into thf Annual Cost of Production of Apples (125 Ranches, Western Colorado), 1914, 1915

	Maintenance cost			Handling cost			Material costs			Fixed costs			Total costs		
	Per acre	Per box	Per cent of total	Per acre	Per box	Per cent of total	Per acre	Per box	Per cent of total	Per acre	Per box	Per cent of total	Per acre	Per box	Per cent of total
	$	$		$	$		$	$		$	$		$	$	
Mesa......	67.77	0.247	26.4	48.24	0.176	18.82	58.25	0.212	22.67	82.51	0.300	32.09	256.77	0.935	100
Delta.....	50.57	.171	21.5	59.42	.202	25.41	56.14	.191	24.02	67.83	.231	29.06	233.96	.795	100
Montrose..	47.64	.176	22.9	58.66	.216	28.16	50.78	.187	24.38	51.27	.188	24.51	208.35	.767	100
District..	56.94	.201	23.8	54.94	.193	22.87	56.32	.198	23.46	71.59	.252	29.85	239.79	.844	100

The Growers' Receipts. Taking the eight seasons from 1912 to 1919 as fairly representative of pre-war and wartime conditions and after and the records of a large number of growers in Yakima, Wenatchee and Hood River, we find the following:

Average Returns to Growers of Box Apples Per Packed Box

1912	1913	1914	1915	1916	1917	1918	1919
$0.436	$1.05	$0.42	$0.71	$0.82	$1.03	$1.55	$1.70
to	to	to	to	to	to	to	to
0.50	1.30	0.58	1.08	0.97	1.13	1.81	2.17

Taking this record it will be seen that the average growers did not make expenses from 1912 to 1917 inclusive. They made a fair return on the investment in 1918 and 1919, but in 1919 it was made at the expense of the buyers, for at destination the fruit did not bring the price paid for it, as 10,000,000 of the 14,000,000 boxes sold were in consumption by March and were sold at $3.18 or less, from which at least $1 was required to pay the freight, icing, breakage and selling cost. The selling prices of the fruit on the Chicago and New York markets in these years were as follows:

AVERAGE WHOLESALE PRICES IN CHICAGO AND NEW YORK FOR BOX APPLES PER BOX, 1912-19

1912	1913	1914	1915	1916	1917	1918	1919
$1.17	$1.83	$1.14	$1.31	$1.79	$2.18	$3.03	$2.91
to	to	to	to	to	to	to	to
1.41	2.25	1.94	1.94	2.16	2.79	4.63	3.58

Taking a number of western growers the cost of production for a box of apples from 1911 to 1920 is shown in the table below:

1911-1915	1916	1917	1918	1919	1920
$0.95	$0.84	$1.01	$1.14	$1.61	$1.81
to	to	to	to	to	to
1.18	1.02	1.06	1.19	1.77	1.87

West Virginia. A survey of Berkeley County, W. Va., during 1912-13 embracing 11,203 acres in 247 orchards shows that 60 per cent of the trees were not of bearing age, and but 6 per cent of them were over eighteen years old. The planting distances are usually 30x30 feet on the square, up to 36x36 feet. Most of the bearing trees are Ben Davis, York, Grimes and Arkansas, although recently there is a tendency to plant Stayman, Winesap, Jonathan, and Delicious. The three-year income from orchards which have been cultivated with cover crops is 108.3 per cent greater than those in sod. The cost of producing a barrel of apples is given as $1.25 and the average selling price as $2.25. The average yield is 40.2 barrels per acre and the profit is given as $40.20. About 50 per cent of the orchards are below the average in yield and income.

A New York orchard. In 1874, 249 apples trees were planted on a farm in Monroe County, New York. The trees consisted of

93 Baldwin, 75 Roxbury Russet, 49 King, 4 Cooper Market and 10 miscellaneous for home use. Trees were planted 35 feet apart or nearly 35 to the acre. When ten years set, 69 of the Roxbury Russett were topworked to Hubbardston. The trees began to bear some fruit in 1888 when fourteen years old, but no commercial crop was produced until 1894 when the trees were twenty years old. Since that time, there have been two crop failures, 11 heavy crops, 6 moderate crops and 7 light crops. A total of 2,770,548 pounds of fruit were taken off, an average of 427 pounds per tree per year for the period 1894-1919 inclusive. This is three barrels per tree or 105 barrels per acre, which is considered a high average. The orchard is in sod, but it has been sprayed. Taking an average of two-thirds of the crop as fit to barrel, we find a yield of 70 barrels per acre of such fruit and 35 barrels of cider and drying apples.

The New York Orchardist. The New York apple grower plants but a small portion of his farm to apples and grows general farm crops on most of his farm,—in marked contrast to the western orchardist who has nothing but fruit and a less acreage on the average than the New York man. The New York plan is safer. It is the development of a century of experience. There is an increasing tendency to give more care to the orchard and to produce fruit of a higher type.

The record of 218 western New York orchards. Records were secured for six years (1910-15) on 218 bearing orchards in Niagara, Orleans, Monroe, Wayne and Ontario counties, New York. The record of the facts may be briefly stated as follows: Acres per farm, 118.65; bearing apple orchards, 14; in other fruits, 20.44, and in farm crops, 73.76. The percentage of farm in bearing apple orchard is 13.38; yield per acre, culls excluded, 84.1 barrels; trees per acre, 35; and average age of trees, forty years. The investment per farm is $25,424; in bearing apple orchard, $7,321; per acre of bearing apple orchard, $514, and per cent of apple orchard to total investment, 29.85. The average cost of production of a barrel of apples for the six years is $1.4124. In detail the items are: Maintenance, 28.59 cents or 20.24 per cent of total; handling, 14.34 cents or 10.15 per cent of total; materials, 58.35 cents or 41.31 per cent of total, and fixed charges, 39.96 cents or 28.30 per cent of total.

The average selling price for the six years was $2.20 a barrel. Ninety-two per cent of the growers produced apples at a cost of $1.95 per barrel or less, and 85 per cent of the men had costs ranging from $1.05 to $1.95 a barrel. The cost of production varied from 75 cents to $2.55 per barrel . Considering all records, 76 per cent of the crop was barrelled, 24 per cent was culls, the gross yield per acre being 111 barrels. The average yield by years is shown below:

AVERAGE YIELD OF APPLES ON 218 WESTERN NEW YORK FARMS

Years	Number of Orchards	Yield barrels per acre
1910	74	81.1
1911	180	82
1912	212	96.2
1913	154	72.6
1914	179	104.4
1915	177	64.1

The influence of the Baldwin apple, which bears in alternate years, is in evidence in 1912 and 1914.

The net profit from apples in New York. The average net profit was 79 cents per barrel, and with an 84-barrel yield the net profit per acre was $66.36. If the interest charge, $25.72, is added to this, we have a gross of $92.08, or a return of 18 per cent on the $514 invested. The average returns per barrel each year f.o.b., growers' loading point, were: 1910, $2.84; 1911, $2.29; 1912, $1.83; 1913, $2.80; 1914, $1.63, and 1915, $2.47. There were variations above and below these figures, due to the variety and the ability of the grower to find a market and effect a good sale. Some men were more skillful than others in these respects. There was an average annual expenditure of 170 man-hours per acre and 90 horse-hours.

Cost of production in western New York. In New York, it will probably be necessary to divide the life of the apple tree into seven periods of a decade each. For the first decade the trees do not maintain themselves; the second decade they may be expected to do so; then follows a period of three or four decades in which the apples are expected to return handsomely, after which there is a period of decline. Unfortunately, no data gives an adequate idea of the operating costs and the returns in these different periods. The Experiment Station at Geneva, N. Y., undertook to keep a record of the cost of handling a Baldwin apple orchard near Rochester, N. Y. In the table on page 363 is given the annual yield of the fruit for the first ten years.

1904-13. The trees were twenty-seven years old at the beginning of the experiment, planted 27 to the acre.

AVERAGE YIELD APPLES PER TREE (1904-13)

Year	Barreled fruit barrels	Culls and drops barrels	Year	Barreled fruit barrels	Culls and drops barrels
1904	2.45	2.13	1909	2.37	1.64
1905	1.42	.74	1910	1.92	.69
1906	2.67	1.44	1911	3.41	2.19
1907	2.41	.88	1912	3.86	1.7
1908	4.18	1.41	1913	4.41	1.02
10-Year Average				2.91	1.38

PRICES AND RETURNS PER BARREL

Year	Barreled fruit	Culls and drops	Year	Barreled fruit	Culls and drops
1904	$1.41	$0.26	1909	$3.35	$1.11
1905	2.80	.66	1910	3.35	1.08
1906	2.00	.34	1911	2.50	1.02
1907	3.50	.79	1912	2.00	.60
1908	2.25	.37	1913	2.00	.97
Average				2.60	.72

The authors of the report state that the tables show the outgo and income in the fourth decade, or the period just preceding the prime of life. Part of this orchard was kept in sod and part of it was given cultivation. Since the yield under sod was not equal to that under tillage, the results are probably not the maximum which could be attained, but they are much better than the average. The orchard is valued at $500 an acre and interest was taken at 5 per cent on same. Spraying was done in the beginning with a hand sprayer, later with a Niagara gas sprayer and in the last three years with a gasoline outfit. The first five years bordeaux mixture and arsenate of lime were used, the last five, lime sulphur and arsenate of lead. The orchard was sprayed three times per season the first five years, and twice per season the second five years, the dormant spray being made just before the buds began to swell, and the second as the blossoms dropped. Pruning was paid for at $2 a day of ten hours, at a cost of $3.56 per acre. Tillage was performed by teams, which were hired at $4 a day of ten hours in the beginning, but later at $5, so that the average was $4.50. The annual cost per acre was $7.39. This consisted of plowing the land in the spring, after which it was harrowed and rolled and then harrowed an average of seven times in the season. The cover crop seed, usually red clover, cost $2.74 per acre. Harvesting, packing, sorting and hauling were done in various ways, the fruit being hauled 1½ miles to the station. The barrels cost on the average 36 cents each, prices varying from 30 to 40 cents. The culls were handled in crates and there was no charge for packages against them. It would seem that but one item really is missing from this list, and that is if the orchard cost $500 to develop to the age of ten years, which it probably did not (more likely $250), this should be amortized certainly in the next fifty years. It would not involve a charge of more than $5 an acre, and might be under this. It should be added to the figures. The annual costs of tillage and of the various expenses for the decade are shown below:

ANNUAL COST OF TILLAGE AND OTHER ITEMS IN WESTERN NEW YORK APPLE ORCHARD FOR THE TEN YEARS 1904-1913, ROCHESTER, N. Y.

Year	Tillage	Cover crop	Pruning	Spraying	Harvesting, including barrels	Price of barrels
1904	$21.25	$12.50	$14.62	$58.22	$210.90	$0.375
1905	34.11	14.60	13.25	44.27	96.85	.30
1906	24.00	6.30	15.12	46.51	231.80	.32
1907	29.13	17.50	18.31	73.84	224.20	.40
1908	28.87	7.80	22.11	50.45	338.59	.36
1909	52.91	7.94	16.69	61.75	229.91	.35
1910	39.70	15.45	13.62	49.70	183.89	.35
1911	44.00	17.91	14.25	51.97	373.20	.35
1912	35.00	21.89	19.50	52.84	415.51	.40
1913	42.24	8.25	21.87	46.35	415.24	.40
Total .	351.22	130.14	169.34	535.90	2,720.09	3.605
Average per barrel	$0.063	$0.023	$0.03	$0.096	$0.604	$0.36
Average per tree .	0.27	0.10	0.131	0.41	2.10	——
Average per acre .	7.39	2.74	3.56	11.28	57.26	——

Cost sheet for a barrel of apples, Rochester, N. Y. Average for ten years—1904 to 1913, 27 trees per acre.

	Per acre	Per tree	Per barrel
Interest on investment	$25.00	$0.9274	$0.21
Taxes	1.50	.0555	.012
Tillage	7.39	.2737	.063
Pruning	3.56	.131	.03
Spraying	11.28	.418	.096
Cover crop seed	2.74	.023	.023
Superintendence	30.00	.0110	.25
Picking, packing, sorting, hauling and barrel	57.26	2.1000	.604
Total	138.73	3.9396	1.288

Yield of the Rochester orchard. The average yield of the orchard for the decade was 79.2 barrels of barrel stock per acre, and 37.6 barrels of evaporator and cider stock. In other words, 68 per cent of the crop was barreled. The average yield per tree was 2.91 barrels of barrel fruit and 1.38 barrels of culls and drops, a total of 4.29 barrels of fruit per tree. The average price for all the barrel stock sold, which includes firsts and seconds, was $2.60 per barrel; for the evaporator and cider stock, 72 cents per barrel. This is believed to be more than the average, because in two seasons gales of wind caused an abnormally high quantity of very good windfalls.

Balance sheet. The average cost of a barrel of apples in above orchard is given as $1.29. In years of low yield it will be nearly double this, and in years of exceptionally high yield it will be somewhat less. Deducting the average from the average returns, there is left a net of $1.31 per barrel for the firsts and seconds, and 79 barrels yield $103.49. Since the culls and drops were sold below cost of production, 72 cents must be deducted from 93 cents, which leaves 21 cents loss. This, multiplied by 37.6 barrels of culls per acre, gives a loss of $7.89 per acre, leaving the average net per acre in this orchard for the decade as $95.60. To this must be added interest paid on the investment. This makes the total $120.60 per acre as the annual ten-year dividend from the orchard.

Data regarding production of New York apples during the decades 1904-13 and 1914-23. During the second decade with the trees thirty-seven to forty-seven years old, in their prime—the average yield per acre was 119.9 barrels; in the previous decade it was 116.8, an average for twenty years of 118.35 or 4.44 barrels a tree.

For the second period the orchard was valued at $600 per acre and at 5 per cent interest the rental was $30 per acre or 25 cents a barrel. Taxes averaged $3 a year for the acre or 2.5 cents a barrel. The work was all hired done, tillage cost $7.39 an acre the first decade or 6.3 cents a barrel and $14.40 an acre or 11.7 cents a barrel the second decade. A team and man cost 40 cents an hour at the beginning of the first period and 80 cents an hour at the end of the second. The cost of cover crop seed, usually red clover, was $2.74 per acre or 2.3 cents a barrel the first period and $7.60 or 6.3 cents a barrel the second decade. Professor Hedrick says it cost more than it was worth. Pruning an acre for the first period cost $3.56; in the second $11.03, or per tree 13.1 cents and 40 cents respectively, and per barrel of apples 3 cents and 9.2 cents. Spraying in the first decade cost $11.28 an acre, 41.8 cents a tree and 9.6 cents a barrel; in the second, $18.44 an acre, 68 cents a tree and 15.4 cents a barrel. Superintendence cost $30 an acre a year for the twenty years. For the first period it averaged $1.10 a tree and 25 cents a barrel; for the second period $1.18 a tree and 26.5 cents a barrel. The cost of harvesting, packing, sorting and hauling for the first decade was 24.4 cents a barrel; for the second 47.2 cents. The crop was packed in the orchard and hauled one and a half miles on a country road. The average price of barrels for the first decade was 36 cents; for the second period 69 cents. Culls were sold in crates without a package charge. The total cost of a barrel of packed apples in the first decade was $1.29; in the second decade $2.12.

THE COST OF A BARREL OF NEW YORK APPLES

	1904-1913	1914-1923	Average 20 years
Interest on investment	$0.21	$0.25	$0.23
Taxes	.012	.025	.018
Tillage	.063	.117	.09
Pruning	.03	.092	.06
Spraying	.096	.154	.125
Cover crop	.023	.063	.043
Superintendence	.25	.265	.258
Picking, packing, sorting, hauling	.244	.472	.358
Barrel	.36	.69	.495
Total	1.288	2.128	1.68

The returns and profits. The average price received for the first decade was $2.60 a barrel for all the barreled fruit and 72 cents a barrel for evaporation and cider stock; in the second decade $3.83 for barreled stock and 80 cents for culls and drops. The average yearly net profit on a barrel of apples, graded and ungraded for the decade 1903 to 1913 was $1.31 a barrel; for the second period $1.71 a barrel or an average of $1.51 for twenty years. The average per acre for the first decade was $95.60; for the second decade $145.83—an average of $120.71.

The above probably indicates the possibilities of apple growing under good conditions and when in the hands of a man who knows the business. It must also be remembered that there were only ten acres of apple orchard on a mixed farm, that the orchard was all of one variety, which was well adapted to the soil conditions and climate; that the trees were in excellent condition and the orchard had been well taken care of up to the time of beginning the experiment. That the profits are many times as great as those from the average orchard in New York; that there was not a season in the whole period in which the orchard was without crop. Crop failures must be expected at more or less uncertain intervals. It would not be wise to assume that if ten acres would make $1,200, that 100 acres could be made to produce $12,000. A farmer limited to a hundred-acre farm, ten of which were in apples, would still be a long way from the millionaire class.

Other New York Orchards. Data compiled by R. D. Anthony, taken from records of orchards which have been under the direction of the Experiment Station at Geneva, N. Y., for two to fourteen years, show that the cost of production of a barrel of apples in New York varies with the yield, that when the yield is above normal the cost per barrel is reduced and in the seasons 1900 to 1914 the average cost was $1.48 per barrel, with an average production of 66 barrels per acre; that under certain circumstances it got down to as low as $1.21 per barrel. Labor per acre involved 145 man-hours, 55 horse-hours for the average orchard, while in better orchards it was 195 man-hours and 73 horse-hours. The summary showed labor cost per barrel 56 cents, material 49 cents, fixed charges 43 cents. These were divided as follows:

Cost of producing a barrel of apples in Western New York, 1900-14:

1. Labor (in cents)—Pruning, 4.5; spraying twice, 5.6; applying fertilizer, 1.5; cultivation, plowing, hoeing, etc., 9.4; harvesting, including picking, grading and packing, 25; and marketing, delivery at shipping point, 10, a total of 56 cents or 38 per cent of total.

2. Material (in cents)—Fertilizer, 6; spraying twice, 5; barrels, 35; and cover crop seed, 3; a total of 49 cents or 33 per cent of total.

3. Fixed charges (in cents)—Interest, 22.75; taxes, 2; machinery, 7.5; buildings, 3, and management, 7.5; a total of 42.75 cents or 29 per cent of the total.

Market returns. In taking the market returns, it is necessary to deduct the cost of commission, haulage, rail transportation and probably brokerage, or some remuneration for the buyer who collects the barrels and makes shipment; for until quite recently very little of the fruit was moved by community packing-houses, most of it was purchased from the farmer and the community packing-house charge must be paid by the commodity. When the fruit sells at $3 per barrel in New York it is necessary to deduct as commission 24 to 30 cents; freight, 22 cents pre-war price, now 52 cents; expenses of the man who assembles the fruit and makes shipment, 25 cents, and loading, 5 cents. In addition, there may be a charge for icing, which formerly was 8 cents per barrel and now is 22 cents. There is always apt to be some shrinkage, or barrels broken, which would certainly involve another 10 cents, so that the total the grower might receive f.o.b. shipping point, prewar, would be $2.06 or 70 per cent of the wholesale sale price, and with present freight rates $1.62 or 54 per cent of the wholesale sale price.

Taking the year 1914, the buyers paid the farmers $1.50 per barrel for ''A'' grade 2½-inch minimum Baldwin and Greening, f.o.b., loading station, New York, and $1 to $1.25 for ''B'' grade, 2 to 2¼-inch minimum. In the case of King, farmers received $1.75 to $2 for ''A'' grade and $1.50 for ''B.'' Out of this, the farmer had to pay 35 to 40 cents for the barrel. At that time, pickers were receiving 15 cents a barrel for picking. It cost 10 cents for grading and packing, 5 to 10 cents for hauling from the orchard to the loading station, or a total of 70 to 75 cents a barrel—so the fruit was worth from $0.50 to $1.25 a barrel. The general estimated average cost of production, per packed barrel of fruit, was from $1.41 to $1.50, for the period 1900-14, with farm labor about 15 cents an hour and horse labor about 12.5 cents an hour; lime sulphur about 12 to 14 cents a gallon and paste arsenate of lead 10 to 12 cents a pound. In 1920, with farm labor at 50 cents an hour and less efficient, barrels $1.50 each instead of 35 cents, it is difficult to estimate the probable cost of a barrel of fruit; however, the best estimates ran about $3.70 a barrel, with $5 to $6 as the cost of ''A'' grade packed barrels in many cases. The cost, however, had nothing to do with determining the price. The crop was large and deflation set in, so that the fruit sold far below the cost of production and sometimes for less than the cost of harvesting, packing, package, storage and freight.

Cost of production in Canada. In experiments conducted by Macoun in Canada, a careful record of the cost shows that in the years 1896-1904 the estimate of $250 per acre as the cost of developing a ten-year apple orchard was approximately correct. This was after allowing for all credits which might have been secured in the meantime. Allowing an average yield of a barrel per tree during the tenth to fifteenth year the cost of production of same averaged $2.01 per barrel. Allowing an average of two barrels per tree from the fifteenth year on, the cost of production would average $1.59 per barrel. Production per acre allowed from the tenth to the fifteenth year was forty barrels, and from the fifteenth year on, eighty barrels. Some growers contended that these figures might be increased 50 per cent, with a corresponding reduction in the cost of producing a barrel.

Some British Columbia Data. Professor Clement, secretary of the British Columbia fruitgrowers' association, as the result of five years' average, reports the cost of production of a box of fruit in British Columbia in 1919 as $1.54, the average yield per acre, 378 boxes. Labor cost was 35 cents per hour or $86.95 per acre. Cost of handling the fruit was 49.48 per acre; cost of materials $18.39. Fixed charges, as interest, depreciation, insurance and miscellaneous, was $94.24 per acre, bringing the cost per acre to $459.40 or $1.125 per box; packing, salary for manager of the orchard, incidental charges, $0.42 per box, total $1.545.

Professor Clement states that the larger the orchard the less the average yield per tree. On orchards of one to five acres the average yield for five years was 6.5 boxes per tree. On orchards 6 to 16 acres, the average was 5.6 boxes; orchards 11 to 20 acres, the average was 4.8 boxes. Orchards over 20 acres had a corresponding reduction in the yield per tree. The yield per tree at various ages was: Trees five years old averaged 2.32 boxes per tree; trees seven years old averaged 4.32; trees eight years old averaged 4.74, and trees nine years old averaged 6.14. The maximum production was reached at nine years of age and from then on practically no increase was shown. The average investment in British Columbia is given as $1,162 per acre. This may be compared with that of the Wenatchee grower of $1,925 per acre; the Yakima grower of $1,000 per acre, Hood River of $990, and the Colorado grower of $635 per acre.

CHAPTER XXXII

THE PEAR

The pears in the United States come mainly from three distinct types: the European and Asiatic pear (*Pyrus communis*), the South European Pear (*Pyrus nivalis*) and the Oriental pear (*Pyrus serotina*). European pears were brought into North America when the country was first settled. They are now established in New England, New York, along the Great Lakes to Michigan, and in the Pacific states. In the Central states, commercial production is precarious owing to the lack of an equable climate and the presence of blights and pests. In the Southern states the climate is usually too hot for the best development of the tree and the fruit. In the North Plain states, the winter temperatures are too low, so that it is not until the protected valleys of the Mountain states and the slopes of the Pacific states are reached that suitable conditions are obtained for the best growth of pears. It is here that pear production is making the greatest advance. Northern Idaho, parts of Western and Southern Oregon and Western Washington and certain sections of California are most admirably adapted to pear production.

The introduction of the Sand pear or Chinese pear, *Pyrus serotina*, in the middle of the nineteenth century, and the hybrids resulting from its use, principally Le Conte and Kieffer, paved the way for commercial pear cultivation in the Southern states. These varieties were believed to be blight-proof, but later it was found they were not. Still, pears are found in varying numbers throughout most of the Southern states. The late P. J. Berckmans, of Augusta, Ga., had 600 varieties on trial at one time, and stated that of this number there were not twelve which were worth growing in the South. The three leading varieties were Le Conte, Garber and Kieffer, all of which are hybrids of the Sand pear. Of these three, Kieffer is probably the most resistant.

COMMERCIAL PEAR REGIONS

California is the leading pear-growing state in the Union. A full crop is about 9,300 cars, 500 bushels each. Normally half the pears are shipped fresh, 30 per cent are canned, 20 per cent are dried. Bartlett is the principal variety.

Washington. The Yakima Valley is the principal pear-growing section in the state. A full crop is about 2,000,000 bushels or 4,000 cars. Bartlett is the leading variety. All the shipments are in bushel boxes, 51 pounds per box, 511 boxes to the loaded car. The crop from this state is increasing.

Oregon. The Rogue River Valley with Medford as its center is the leading pear-growing area and ships from 560 to about 800 cars of 512 boxes each. The Hood River Valley ships up to 150 cars. Bartlett, Bosc, Howell, etc., are grown. A full crop is about 1,350 cars. The shipments are increasing in volume.

Colorado. Commercial pear growing is confined to Mesa County. A full crop is about 450,000 bushels or 900 cars.

Utah. The Provo District of Utah County has some commercial orchards and has shipped 35 cars.

New York. This is the leading commercial pear-growing state in the East. A full commercial crop would be about 1,800,000 bushels or 3,600 cars. In Western New York, Niagara is the leading county, with heavy production in Wayne, Monroe, Ontario, Orleans and Oswego. Fifty to 60 per cent of the crop is Bartlett. Kieffer, Seckel and Clapp are important. In the Hudson River territory Columbia County leads in production, followed by Greene, which some years ships several hundred cars, then Ulster, Orange, Rensselaer, Albany and Dutchess. Bartlett constitutes about a third of the plantings, followed by Kieffer, Seckel and Clapp. Bosc, Duchess and odd varieties make up the balance. Shipments are made in barrels and bushel baskets and a large portion of the crop goes to market by boat.

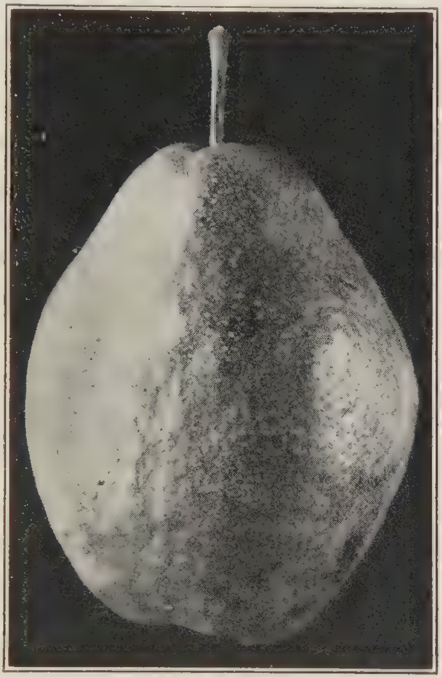


FIG. 76. Fruit of Kieffer Pear. The leading commercial variety of the Sand pear hybrids.

New Jersey. Burlington County, with Riverton and Marlton as important centers, leads in production with a normal crop of about 200 cars or 100,000 bushels. Cumberland and Camden counties follow, and about fifty cars move from Monmouth County. Most of this fruit moves by truck to local markets. A full crop is placed at about 600,000 bushels or 1,200 cars. Kieffer constitutes 60 per cent of the total. Bartlett about 18 per cent. Le Conte, Duchess and Seckel are grown.

Delaware. Wyoming is probably the leading shipping point. A full crop is about 1,800 cars, 800,000 bushels or 1,500,000 five-eighths bushel baskets, the package generally used. Kieffer constitutes 90 per cent of the crop; Bartlett, LeConte, Seckel and Duchess make up the balance.

Michigan. Berrien county normally produces 58 per cent of the crop. Van Buren and Allegany counties produce about 26 per cent. A full crop is estimated at about 1,400 cars. Much of the crop is moved by express and by truck, a limited amount by rail. Kieffer constitutes nearly 60 per cent of the acreage, Bartlett about 20 per cent, Anjou, Clapp, Seckel and Duchess, etc., the balance.

Illinois. Marion County, with Alma and Salem as important centers, produces about 30 per cent of the crop. Union and Pulaski counties produce about 28 per cent of the crop. The balance is scattered. A full crop is about 315,000 bushels or 630 cars. Much of the fruit moves by express. Eighty-five per cent of the acreage is planted to Kieffer. The common package is the bushel basket, but some growers use barrels.

Missouri. Pike and Daviess are the leading counties. Pear production in this state is on the decline. A full crop would be 85,000 bushels or 170 cars. Kieffer is the principal variety. Local demand consumes practically all of the crop.

Texas. The commercial pear orchards are scattered. The irrigated region round Clint and Ysleta near El Paso is the most important, with nearly 60 per cent of the production. Bartlett and other high quality fruits are grown and shipped in boxes. In Smith and Cherokee Counties between Tyler and Jacksonville is a region which grows Kieffer as the leading variety. A full crop is about 100,000 bushels or 200 cars. The above sketch will show the important part played by climate in determining the pear-growing areas of the United States.

Soils. Pears are grown on a variety of soils, but usually clay loams are preferred. A deep soil is desirable. On sandy and sandy loam soils, the trees are apt to make rapid growth but are shorter lived. Kieffer and its allies are much better suited to light soils than are Bartlett and Seckel in New York and south of that state. Pears are grown in a small way over most of the Eastern states and any soil which is moderately rich is used. Rich black soils in which growth cannot be controlled are not regarded favorably. Although a good soil is desired it is better to have a soil somewhat low in condition and plant food, one in which growth can be controlled, than the reverse. In the former there is a chance of success, in the latter there is none. Growth will be so rampant and the chance of loss from blight so great that it would be wiser not to begin. In California clays and clay loams are in use because, on such, other fruits do not do well; hence the heavy soils are regarded as the pear soils. A good supply of moisture is desirable.

Pear stocks in Oregon. Owing to the ravages of fire blight on the Pacific Coast, the importance of a blight resistant stock for pears has become evident. The pear seedlings used in the East are usually *Pyrus nivalis*, French seedlings; generally these are quite susceptible to fire blight, and frequently the root becomes affected when the top is not. The Oregon station regards the Japan pear seedlings (Chinese Sand Pear) as the best seedlings for this region because they are not so subject to blight as the European seedlings. Up to the present time in the vast collection of apple and pear seedlings from all parts of the world at the Oregon Station not one has proven immune to fire blight, although three species have been found in which thus far it has not been possible to produce the blight by inoculation in wood more than one year old. Most of the resistant types come from China, although some are from Northern India.

It is suggested that for the western regions of this country the Japan pear seedling and other types of the Chinese Sand pear group may prove most satisfactory for stocks, but that for the warmer regions, *Pyrus calleryana* and its various types may prove of value. This plant is common from Southern to Central China, and thrives from little above sea level to 5,000 feet elevation. In the case of *Pyrus ussuriensis*, heralded as immune, it is found that some plants show resistance to blight while others do not, and seedlings vary so markedly in this respect that the only way to propagate a resistant stock, once it is found, is by rooting cuttings, layers or some other means of asexual multiplication. The problem now to solve is the type of union our cultivated varieties of pears will make with such stocks, some reports are unfavorable. The varieties Surprise and Old Home are reported as immune to fire blight in California and attempts are being made to develop a commercial means of getting them on their own roots and then topworking.

Propagation. Most pears are propagated on standard roots. There are relatively few dwarf trees in this country. The dwarf pears are on quince roots. The stocks used in the East are the French pear seedlings. These are usually grown in France in large quantities, relatively few seedlings being raised in this country. In California and in other Pacific Coast states an attempt is being made to use Japanese pear seedlings because the root is less apt to fire blight. A number of varieties and types of Chinese and Japanese seedlings are on trial. It is essential that not only shall the European varieties used make a good union with these seedlings, but that the trees shall be sufficiently long-lived to make it worth while. The Japan root is much more resistant to fire blight and appears to be somewhat more resistant to aphis than the French seedling root. It does not dwarf the trees.

Budding. Most pears are propagated by budding. The trees are usually sold as one- or two-year-old buds, although some of the weaker-growing varieties as Bosc and Winter Nelis may be retained three years in the nursery in order to get sufficient size to meet the demands of the trade. Other varieties, especially if well grown, make very large and handsome trees at two years of age. This is true of such kinds as Kieffer, Colonel Wilder, etc. Some varieties, as Kieffer, Le Conte and Garber, can be easily propagated from cuttings. If this is done, the young trees should be root-pruned to encourage a better root system.

The quince stock. Not all varieties will unite equally well with the quince stock, hence such should be double worked. A variety such as Duchess, which unites quite well with the stock, is budded first and then the desired variety is budded onto the trunk of Duchess so that eventually the root is quince, the trunk or part of it is Duchess, and the top Bosc, Seckel, Winter Nelis or the desired variety. There is little place for dwarf pears except in the home orchard or home garden. They are not usually commercial. If dwarf trees are desired for commercial use, it would probably be better to use the dwarf-growing pear seedlings as the stock rather than quince.

Stock relationships. The following lists are suggestive:

1. Pears which succeed better on quince than on pear stocks are Duchess d'Angoulême, Beurré Diel, Easter Beurré, Glou Morceau, Louise Bonne, Vicar of Winkfield.

2. Pears recorded as succeeding equally well on pear and quince are Beurré d'Anjou, Bloodgood, Doyenné Boussock, Buffum, Colmar, Beurré Hardy, Jargonelle, Kingsessing, Josephine de Malines, Osband, Pound, Rosteizer, Beurré Superfin, Tyson and White Doyenné.

3. Pears growing on quince, but better on pear stocks are Beurré d'Arenberg, Bartlett, Gray Doyenné, Lucrative, Onondaga and Seckel.

4. Pears usually failing on quince, unless double-worked, are Beurré Bosc, Dix, Dunmore, Marie Louise, Sheldon, Washington and Winter Nelis. Conditions influence the results. The Seckel has sometimes failed on the quince, at other times, under similar conditions, it has succeeded. Louise Bonne de Jersey

seems to have been consistently succesful when grown on quince. Beurré Bosc has been a constant failure unless double-worked and in some places even when double-worked it is not a success. Rivers states that the quince root improves the flavor and appearance of the fruit of Glou Morceau and Easter Beurré.

Topworking. It is frequently desired to topwork varieties and definite information regarding adaptability is lacking. Kieffer has been successfully topworked to Worden-Seckel, Bartlett and Bosc in western New York by taking two or three seasons to do the work. Limbs two to three inches diameter may be worked by grafting in the bark. This seems preferable to cleft grafting. Buds may be placed in new wood. More failures than successes are recorded.

Planting. One- or two-year-old trees are usually used. The roots of some varieties are quite prongy and care should be taken that the soil is packed firmly around all roots. Fall planting may be practiced with profit wherever the seasons permit but usually spring planting is preferred. Planting should be made early before the buds start since pears do not start latent buds as easily as apples, and the buds are very easily rubbed off when growth has started. In addition, weak trees are easily attacked by blight and the loss is increased. The chief advantage of one-year-old whips is that one can start the head as low as desired, while in many two-year-old trees the head may have been started with the lowest limb at 3 feet from the ground. For upright growing varieties like Kieffer, Col. Wilder, Clapp and Anjou, one may wish to start the head low. Pears are usually planted closer than apples. Common distances are 20x25 feet or 25x25 feet in the East for standard trees, and 16x16 feet for dwarfs, although some advise them as close as 12 feet. This, however, gives little opportunity for cultivating the land.

Forming the head. A low-headed tree is desirable. Such trees come into bearing earlier, are more profitable and are easier to harvest. There is a great question as to whether it is better to maintain a leader or to develop an open-center tree or a modified leader. Theoretically, a well-balanced tree is wanted. Many trees, if left to themselves, will develop into most stately specimens. Four or five main branches are needed. If a leader is kept, it should not be permitted to fork. On the main branches develop two or three primary branches and let the whole be covered with fruit spurs so that the fruiting wood can be kept in the center of the tree where the load can be easily borne.

Pruning. Very little pruning is done for the first three or four years in the East, just enough to shape the tree. Limbs that cross the tree or are not needed are removed. On the other hand, many successful growers of the old school have a system of shortening in all branches one-third to one-half and maintain the system. This pruning is done in the winter when the wood is dormant. This system works all right for a variety like Kieffer on light sandy land where the tree is apt to make a long, willowy growth and is apt to overbear. On heavier land where the growth is of a somewhat different character the same

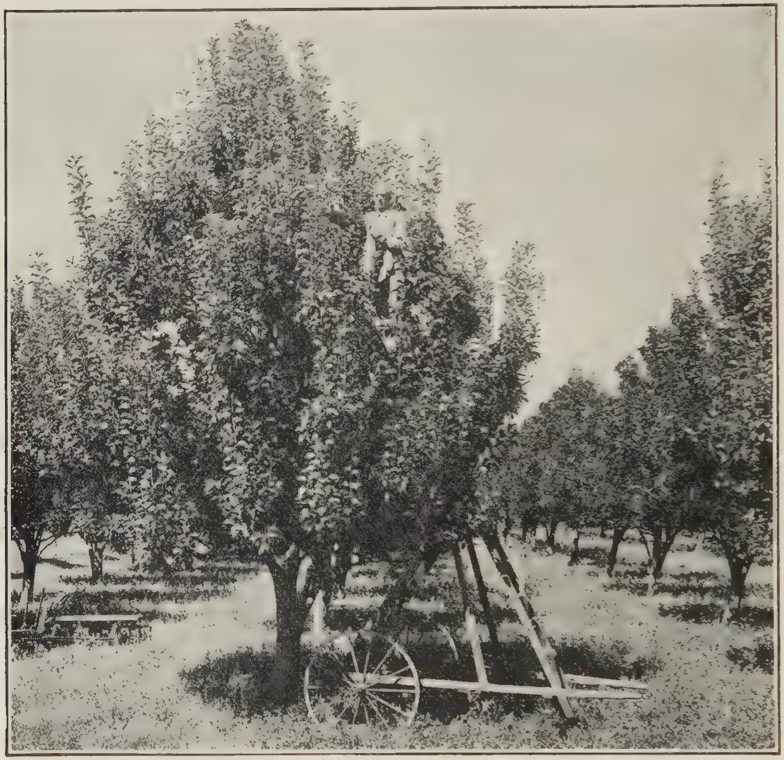


FIG. 77. Kieffer Pear trees in orchard of L. L. Morrell, Kinderhook, N. Y. Soil sandy. Strong vigorous growth is maintained by pruning the shoots back to three buds each year. This restricts the number of fruit buds formed and maintains ample foliage. The fruits make large size. Note the ladder on wheels. A pair of buggy wheels is used.

policy with the same variety is unprofitable. After all, the successful handling of a pear orchard begins with the formation of the tree. Remove a branch any time it is found not to be needed, but give as little pruning as possible until the tree is in bearing if early bearing is desired. Some growers draw the branches toward the ground and tie the tips to the trunk to spread the young tree and induce earlier bearing.

Later Pruning. The pruning of the bearing trees will depend upon conditions. Pear trees are most apt to succumb to blight during the first few years of bearing. As they get older they appear to develop immunity, especially if there has been a moderate amount of blight, not an epidemic, in the orchard or vicinity all the time. The pears are borne on spurs which continue to branch and bear for a number of years before they lose vitality and need renewal. The maintenance of sufficient new wood and of spurs of sufficient vitality so that they will set a crop is the test of a successful pear grower. If the trees become so covered with fruit spurs that they produce a mass of bloom and set no fruit (and this is not due to lack of pollination) the remedy may consist of the removal of half the fruit spurs to stimulate more leaf development over all of the tree. Too great a growth of wood is as serious as too little, and perhaps more difficult to handle. One may need to reduce the food supply and cut off the water supply.

I have seen Bartlett trees which had become a mass of bearing wood and were not productive reinvigorated by severe "pruning" taking several feet off the top, lowering the head and stimulating a mass of new growth which was most skillfully put to work. I have seen the same done with Kieffer when the trees have shown lack of vigor as after two or three years of infestation with Psylla. The trained trees seen all over Europe, on the walls of cottages and on the walls of gardens, are a standing proof of the amount of pruning which may be given to a bearing pear tree. No other tree will withstand more and continue to bear fruit, provided one studies the tree in all its moods.

In the East some of the most successful growers give thorough cultivation in the spring and up to July when they seed the orchard to a cover crop, much the same as is advised for apples. Others leave the orchard in sod, grazing the sod closely with sheep. They get fair crops of fruit, the trees making a slow and steady growth. In the West, where irrigation is practiced, tillage and the use of cover crops, or mulching, is practiced as outlined for apples.

Fertilizers. Some growers not only cultivate and grow cover crops, but in addition apply annually a certain amount of manure. Others loudly proclaim that no manure should be put on a pear orchard. If one is getting regular crops by applying manure it is wise to continue the work, keeping a watchful eye on the trees for any sign of warning. Frequently, manure is applied in the autumn. In some cases it is a custom to put mulch under the trees to catch any fruit which may fall and to aid in conserving moisture. Where manure is not available commercial fertilizers may be used. The amount of nitrogen used is usually small, in many cases more can be used to advantage. The fertilizer will depend very greatly upon the soil. On sandy soils in New Jersey, where heavy and regular crops of Kieffer pears are borne, there is no alternative but to apply fertilizers in quite liberal amounts; it is unprofitable to do otherwise. Mixed fertilizers are applied at the rate of half a ton per acre. On richer soils, where good cover crops are grown, the use of fertilizers may not be necessary. Nitrate of soda alone may be a great help in giving size and finish.

Pollination. Most pears appear to be sterile somewhere. For instance, Bartlett is able to pollenize itself in Western New York, but it cannot do so 400 miles away in New Jersey. It is self-sterile in parts of California and better yields result from cross-pollination in all parts. Seckel is a good pollenizer for it. Kieffer cannot fertilize itself in New Jersey, but it can in Western New York. Garber or Le Conte are both good pollenizers for it. It is wise, therefore, in planting pears, to arrange for cross-pollination. One plan is to plant four rows of Bartlett and two rows of Seckel or Bosc, repeating this through the orchard. This is good practice even in locations where varieties are reasonably sure, since in an adverse season it may insure a crop. It is desirable to have a pollenizer which has a relatively long period of bloom or arrange for varieties which will extend the time of bloom. The honey bee is a material factor in transferring the pollen.

Thinning. Some varieties need thinning in order to get adequate size. This is particularly true of Kieffer. One way to thin is to prune heavily, removing parts of the crop in this way, but where this is not done there is nothing else but to go over the trees as soon as the crop is well set and remove all defective fruit and thin to 4 to 8 inches apart. Some varieties thin themselves as for instance Bosc; it is seldom that a tree of this variety overloads. Vermont Beauty, Seckel and Kieffer are varieties that need thinning in order to get good sized fruit when the tree is bearing a load. To get size, an adequate amount of wood growth must be made by the terminals of the bearing branches.

Dwarf pears are usually grown by amateurs and specialists. They are a commercial proposition only in exceptional cases. In California where the root aphis or root louse (*Eriosoma pyricola*) is a serious menace on pears, the quince root is used because it is not attacked. Since Bartlett is the variety usually grown in California it is usually double-worked on Hardy; that is, the root is quince, the trunk or the basal 12 inches of it is Hardy and above this is Bartlett. Many growers contend that double-worked trees possess advantages over single-worked. The trees are often planted 16 feet apart or 170 to the acre, although some advise 14 feet or 221 to the acre. The trees are always headed low, with the lowest limbs near the ground. They attain a height of 10 to 12 feet and the aim is to give them a spreading top. The ease with which the trees can be sprayed, thinned and harvested and the fact that a number of trees of different varieties can be grown in a small area commends them to the home planter.

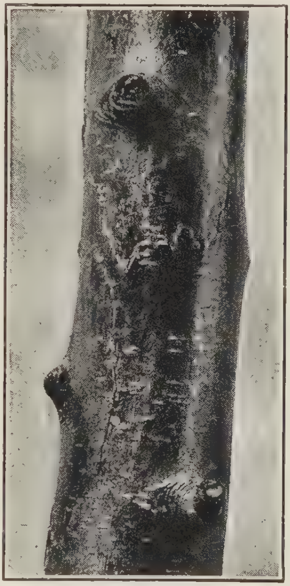


FIG. 78. Fire blight canker. A holdover canker on pear. It surrounds a stub of a twig which was attacked by fire blight. The marginal depression shows the extent of the canker

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Diseases. Fire blight, blight and pear blight is frequently first recognized by the blackened leaves or twigs as though burned by fire. It is caused by bacteria (*Bacillus amylovorus*) which move in the sap and are very quickly transported from one part of the tree to another so that in twenty-four hours the disease may pass down a branch and onto an important limb. The disease is of American origin. European apples and pears readily succumb to its ravages. Since the disease has been present in Asia for a long time it is hoped that plants may be found there which possess immunity. In time, a race of immune pears may be found. Today all that can be done is to cut out affected wood as soon as found. During the season of active growth cut a foot below the apparent end of the affected area and disinfect the tools and the cut surface of the limb with a solution of corrosive sublimate, one part; cyanide of mercury, one part in 500 parts of glycerine and water, in the proportion of three of the former to one of the latter. For cankers, the heavy bark may be shaved down or scarified to permit these disinfectants to penetrate to the sap. Another valuable disinfectant is ½ per cent potassium iodine solution, plus 1 per cent iodine in denatured alcohol. This may be applied to cankers. Zinc chloride is also on trial. In the winter, the trees should be gone over and all holdover cankers, due to fire blight on the wood, cut out and disinfected, thus removing these centers of infection for the following spring. It is the gummy sap oozing from such which furnishes the material for infection of the new growths. Insects, birds, men and other agents will aid in transferring the organisms. The disease travels northward in spring. Control methods have done much to reduce the ravages of the disease, especially when undertaken by the community. Some varieties as Seckel are less subject to its attacks than Bartlett. This appears to be correlated with the time during which active growth is made; this in the case of Seckel is quite short, in Bartlett it is longer, so that the time in which infection may take place is much less with Seckel than with Bartlett. The possibility of developing pear seedlings in which this character is more fully developed is recognized and is being investigated at certain experiment stations.

Pear scab (*Venturia pyrina*) resembles scab of the apple. It attacks the pear from New York to California. Flemish is quite susceptible to it. It attacks the leaves, twigs and fruit. The disease winters over on infected twigs. Control is by spraying with bordeaux mixture, 4:4:50, as the blossoms show pink; again after the blossoms fall, and again two weeks later, and perhaps later if weather conditions necessitate; or dusting several times with copper sulphate and lime dust.

Leaf spot (*Mycosphærella sentina*) is a fungus disease that causes spotting on the leaves and the leaves to fall from the trees. The disease lives over on the fallen leaves. Use bordeaux mixture as for scab.

Leaf blight (*Fabræa maculata*) causes a spotting on the leaves twigs and fruit, and the fruit to crack as though attacked by scab. Use bordeaux mixture as for scab.

For other diseases see Apple.

Insects. Pear psylla (*Psylla pyricola*) undoubtedly is today one of the worst insect pests of the pear. It may be said to be a jumping plant louse. It lives by sucking sap. There are several broods. In New York, the adults lay eggs on the bark in early spring which hatch in about three weeks and become nymphs that immediately begin to suck sap from the young leaves and twigs. They are usually seen in the axils of the leaves. In two or three days they are covered with honey dew which finally becomes so abundant on the leaves that they are sticky with it. The leaves become stunted and fall. Attack follows attack during the summer. The foliage comes off and the weakened tree may die during a severe winter. A sooty fungus lives on the honey dew and the affected fruits may turn black. Spraying with soap and nicotine before harvest will prevent this. A method of control may be arranged from the following:

1. Clean up the orchard.
2. Scrape off all old rough bark, but not down to live wood, thus reducing breeding places. Burn the scraping. Usually not worth while.
3. In November or December, spray with Blackleaf 40, (three-quarter pint to 100 gallons) and three pounds of soap on days when it is not freezing; or use scalecide or some miscible oil, 1 gallon to 15 of water, but be sure the temperature is 40° F. or above while the tree is wet with these materials.
4. As the cluster buds are separating in spring, spray with miscible oil, scalecide 1 to 15 or lime sulphur, 1-8 to kill the eggs.
5. As soon as the blossoms fall, spray with nicotine sulphate (three-quarter pint to 100 gallons and 3 pounds of soap) if the Psylla have not been controlled by other sprays.
6. In the growing season, dust with hydrated lime, thoroughly coating the trees. Not always effective.
7. A valuable spray for foliage is three-quarter pint Blackleaf 40, 2 pounds copper sulphate, 60 pounds lime in 100 gallons water. Keep it thoroughly agitated.
8. A 3 per cent nicotine dust may be applied whenever the insects are numerous.

9. A 25 per cent calcium cyanide dust is as effective as 2 per cent nicotine dust. Ground talc is used as the carrier.

Pear slug (*Eriocampoides limacina*). Small, shiny, dark green or nearly black slugs may be found feeding on the upper surface of the leaves of pears and cherries. Spray with arsenate of lead, 1 pound powder to 50 gallons of water. Dust with hydrated lime, road dust or any fine powder.

Blister-mite (*Eriophyes pyri*). This mite lives between the upper and lower layers of the leaf. It burrows in from below, causing brown spots on the leaf. The leaves when badly infested, turn yellow and fall. The mites winter under the bud scales. As the leaves are breaking when the leaf buds have just shown green, the mites are moving, and spraying at this time with scalecide 1 to 12, or some miscible oil, or lime sulphur one to 12 or if San José scale be present, 1 to 8 will destroy both at the same time. Some prefer fall spraying as soon as the foliage is off.

The Sinuate pear borer (*Agrilus sinuatus*) is a European borer, now well established in New York, which works under the bark. The eggs are deposited in crevices on the bark of the branches and trunk. These hatch about July. The larvæ burrow into the sapwood, girdling the branch or the trunk, weakening it and rendering it unproductive, or they may kill it. The beetles feed on the foliage late in May and keeping it coated with an arsenical poison is advised. Deterrent washes on the bark may prevent oviposition.

Round (*Saperda candida*) **and flat-headed** (*Chrysobothris femorata*) **borers.** These do considerable damage to pear, apple and other fruits. The grubs or larvæ do the damage when they make their tunnels. They may girdle the trees, causing same to be unproductive even though the trees do not die. They pave the way for collar rot and blight infections. Inspect and dig out the borers twice a year. Probe the holes with a wire or inject carbon bisulphide and plug the hole with grafting wax. Keep the trees healthy, vigorous; such are less subject to attack.

San José scale (see Apple). **Oyster shell bark scale** (*Lepidosaphes ulmi*). This resembles a small oyster shell and sometimes the bark is covered with them.

Scurfy scale (*Chionaspis furfura*). This is distinguished from oyster shell by its greater breadth and white color. Sprays for San José scale will usually control all. If not, about the middle of June, when the young scales are hatching, spray with fish oil soap, 1 pound to 5 gallons of water, or use kerosene emulsion.

Codling moth (*Carpocapsa pomonella*). This is the same insect that causes the wormy apple; it is controlled as described under Apple.

False tarnished plant-bug (*Lygus invitus*). The nymphs stab the skin of the pear while the fruit is small and cause the skin to appear corky and granular and the fruits to become deformed and undersized. At the same time, it often transfers the bacteria which cause fire blight. The crop of fruit may be lost by it. As soon as the blossoms fall, if the insects are present in quantity, spray with nicotine sulphate, three-quarter pint to 100 gallons of water and 3 pounds of soap or apply the nicotine in the codling moth spray, or dust with nicotine in lime.

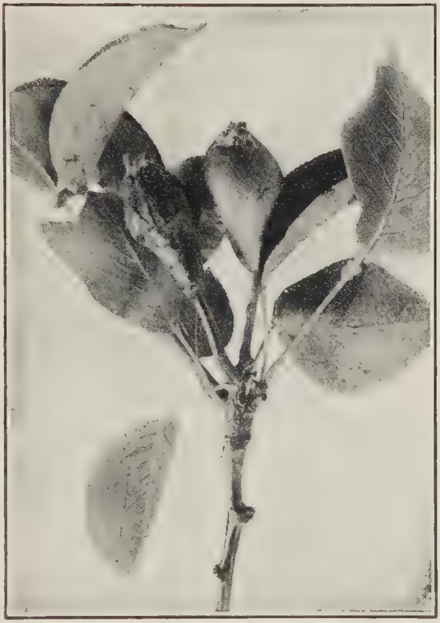

FIG. 79. Pear showing young fruit attacked by fire blight. Some insects as the false tarnished plant bug in stinging the fruit transfer the blight bacteria causing considerable loss

The pear midge (*Contarinia pyrivora*) gives trouble in parts of America, causing the fruits to be stunted and deformed The affected fruits contain tiny maggots which work round the core. The eggs are laid in the unopened blossoms. The larvæ, after feeding round the core for a while, enter the ground where they pupate and emerge the next spring. One suggestion is to give thorough tillage during June and July to destroy the insects as they enter the ground to pupate. Nicotine dust may control.

Pear thrips (*Euthrips pyri*). These small insects appear in large numbers and feed on the opening buds and later attack the flowers. At the time the flowers are in full bloom they appear as though struck by blight. The bark of the spurs and buds may be wet with the running sap from the injured parts. The eggs are deposited in the blossom, leaf and fruit stems. They hatch in a few days, feed a couple of weeks and then fall to the ground to pupate, emerging the following spring to complete the cycle. While the buds are opening, as the scales are separating, spray with miscible oil and if necessary apply nicotine sulphate-lime dust when the petals drop, or use three-fourths pint nicotine sulphate to 100 gallons of water and 3 to 5 pounds of fish oil soap. Apply as a fine driving spray, and force it into all buds. Applying a heavy coat of whitewash as the buds are breaking gives some protection. The wash is made of 80 pounds of quick lime in 100 gallons of water, which should be well strained before applying, but miscible oil is easier. Fumigation of the soil under the trees with granular calcium cyanide by sprinkling ¼ to 3 pounds under each tree and raking in late in May or as the thrips are emerging destroys them. Apple maggot may be controlled in this way.

The Pear Root Aphis has been controlled in California by the use of paradichlorobenzine.

The plum curculio sometimes attacks the pear. It hibernates in brush and woods. Burn all brush, spray with arsenate of lead just after bloom. (See Plum). Bud moths, leaf rollers, green fruit worms and some of the other insects which attack apples likewise attack the pear. (See Apple.)

Harvesting—Pears are not allowed to become fully ripe on the tree. Cross-pollenized pears ripen earlier than self-fertilized. As soon as the fruit has attained sufficient size and color showing a faint yellowish tinge, and generally as the seeds are beginning to show a tinge of brown, the fruit is gathered. A variety such as Clairgeau should have color. Sometimes two pickings are made, leaving the small fruits for later, but more often all are gathered at one time. Another generally accepted indication that it is time to gather is when the stem parts readily from the twig. This is easily determined by lifting the pear upward, although frequently Bartletts are gathered a little in advance of the time they easily separate. This is true of varieties which are apt to drop as Anjou and Clairgeau. Pears harvested too early will wilt, lack flavor, quality and are deficient in texture and have lower market value.

Attempts are being made to determine the ideal degree of maturity at which each variety should be harvested and to work out a method of ascertaining the degree of maturity reached by the fruit. Determination of the starch content by applying iodine to the cut surface is on trial.

Mode of harvesting. The fruit is always hand-picked; usually into pails or baskets, which should be padded or lined so that the fruit will not be injured. Specially designed picking bags are used in the West. The fruit is emptied from the picking basket into bushel baskets or into crates in the East, and into lug boxes in the West in which it is hauled to the packing-shed or to cold storage.

Storage. In the East, where much of the fruit is bought by canning factories and the whole crop is contracted for, it is quite common to haul the fruit from the orchard as picked and place it in cold storage in crates or bushel baskets, both packages being suitable for storage purposes. The fruit is sorted out and graded as used. In storage it should be recognized that size of fruit is no measure of the degree of maturity. Fruit harvested too early is decidedly inferior in quality to that harvested in the middle or late-middle portion of the season. Pears picked in the middle of the picking season will keep better and longer in storage than those picked too early. When the temperature and humidity are both high pears do not mature. Pears held at 95° F. kept 14 to 21 days longer than those held at ordinary temperatures. Most rapid ripening takes place at 68 to 85° F. Higher temperatures inhibit the enzyme which causes dissolution of the cementing material between the cell walls. Both temperature and humidity are important factors in the proper ripening of pears. Some varieties as Bosc will tolerate more delay than others in reaching storage, without any injurious effects. The storage temperature affects the life, Comice pears kept 138 days at 30° F., 125 at 32° F., and 107 days at 36° F. Immature fruit kept best and showed less wilting and scald at 36° F.

The package. In the East, the barrel has long been regarded as a standard package. The pears are picked green and hard. The face is formed with good-sized specimens placed on their side. In the case of large fruits these are usually backed with good fruit, followed by the run of the grade into the barrel. The barrel is racked from time to time. The tail of the barrel may be ringed—good specimens are laid in position and the head is put in. A corrugated cardboard is put on the face and tail of the barrel. The barrel is marked with the name of the variety, the grade and size of the fruit and the name and address of the packer. The fruit is immediately put into cold storage or shipped.

The barrel is too large a package to be kept long in common storage. Pears are too risky a fruit to keep long in a closed package like a barrel, except in cold storage. Even there a variety like Kieffer will sometimes go down in a very short time so that instead of firm, hard pears, one has a mass of jelly and water, and a surprising amount of it is water.

The crate. The bushel crate is a very good package for holding the fruit for the nearby markets. It is usually necessary to deliver pears over a considerable period of time. Sometimes it is necesary to ripen the fruits in order to get the most from them. The crate has the advantage in that it is strong enough to be used in the orchard. The fruit is put into it and is not touched again. Injury results from pouring from one package to another. Crates stack up easily, allow the fruit to cool quickly (which is vital to the successful storage of Bartletts) and are acceptable packages for canners because they can be returned, and are less costly than gift packages.

The bushel basket. For shipment to market, the bushel basket has grown rapidly in favor. It is light, easily handled and readily loaded into the car. The fruit cools quickly in it and is easily inspected. One can make a very attractive display by placing the face in position by hand, sometimes wrapping the fruit; but it is for the purpose of moving a relatively large amount of honestly graded fruit with little expense that the basket has come into favor. A corrugated cardboard or a cushion is usually used to protect the top layer from the cover. The ease with which the cover is removed and replaced makes it handy in inspecting the contents.

The box. For western shipments and for the fancy fruits the box is regarded as the standard package. Fruit is graded to size, wrapped and placed in position on its side in much the same way as apples are packed. The fruit is packed with a bulge and the general procedure is much the same as outlined for apples.

Selling pears. The markets usually want the fruit hard and firm, well graded and well packed in the sort of package the particular market requires. In such condition it can be handled and passed on to the retailer, who may hold it a week without loss from decay. The consumer on the other hand wants the fruit ready to eat. This then is the difference between catering to a retail trade and to the wholesale. The grower of carlot quantities must consider the wholesale market requirements. For one who has a local trade, the fruit should be so stored that it can be ripened as needed and passed to the consumer in small quantities in packages which will command the maximum price.

The European trade. What this trade will amount to in the future, is problematical. The trade during the five years of war was practically nil. To get any idea of the European market in the past, one must go back of the war period. Whether it will be a similar trade in the future will depend upon conditions. There will be readjustments. Whether America will take a strong position as an exporter of this fruit or not, will depend upon many factors. France supplies a little over half of the British market, with Belgium usually second and the United States third. A pear satisfactory to the Christmas trade will have little opposition in the British markets because the French and Belgian pears are difficult to keep so late. As soon as pears begin to soften British dealers do not care to handle them. One of the finest openings for fruit is this British market for winter pears. In pre-war time, fruit dealers paid from 2 to 3 cents each for pears in 20-pound boxes of from 40 to 50 pears. The following varieties are known on the markets: Clairgeau, Hardy, Comice, Anjou, Easter Beurré, Duchess, Charles Ernest (an exceptional favorite as a winter pear), Belle Magnifique, Glou Morceau (a high-priced and popular winter pear), Josephine de Malines (one of the best winter pears). In certain seasons, the Kieffer has proven a splendid seller. Small pears, such as Winter Nelis, however luscious, do not seem to answer the demands of this market.

During the latter part of February consignments of Bartlett pears may be expected in the British markets from Cape Town, South Africa, under the name of "Bon Chrétien" also known in the street as "Williams pears." The same pear was introduced into America by a Mr. Bartlett, and hence in the United States is known as the "Bartlett" pear. Thousands of boxes of these pears are consigned to the British markets and the trade continues until May. The Royal Horticultural Society of Great Britain has taken commendable interest in the development of horticulture in South Africa and other parts of the British Empire. The pears from Africa are shipped in single-layer boxes of 28 pears each, and have sold at $1 per box from the commission houses. The fruits come by steamer, Cape Town to London, a distance of over 6,000 miles, requiring about twenty days for the trip and are landed in good condition.

CHAPTER XXXIII

THE QUINCE

The quince (*Cydonia vulgaris*) is not grown extensively. Seventy per cent of the crop is grown in New York, Pennsylvania and Ohio. The whole output seldom exceeds half a million dollars in value. Individual bushes are grown on many farms and in yards, but the commercial crop is secured from small patches ranging from a few trees to 20 acres. There is no large demand for the fruit; hence, there is little prospect of large orchards, although some believe that many markets could be developed if there was a larger supply.

Favorable factors. In regions adapted to quinces the following factors are favorable: (1) The bushes bear regularly if given care. (2) They are small and many are grown on the acre. (3) The bushes are easily sprayed, thinned and harvested. (4) They usually bloom well after danger of frost is over. (5) The fruit is easily handled. (6) The bushes are extremely handsome when in bloom and in fruit.

On the other hand, as against their advantages, quince bushes are extremely susceptible to fire blight. Where this becomes epidemic, two-thirds of the plants may be killed in a single season. Young plants not yet in full bearing are more easily destroyed than old ones. The plant should always be grown as a bush, not as a small tree, so that if a main limb becomes affected, it can be cut out without interfering with the rest of the tree.

Soil. Heavy clay loams in good condition are usually preferred. On sandy, light soils, the trees may bear earlier, but they are seldom as long-lived and frequently are more susceptible to fire blight. The quince thrives best under relatively moist conditions.

Propagation. The Angers quince is usually used as stock by the nurserymen. These stocks are grown from seed and budded to the desired variety in the nursery. The seedlings are quite variable. At least six different types have been isolated in the seedlings sent out under the name Angers. Not all of these are equally desirable. Varieties may be propagated by means of hard wood cuttings, as in the case of grapes; by layers, either mound layers or otherwise; or by root grafts, apple roots being used, which are removed when the tree is planted, leaving the roots of the quince intact. The commercial method is to bud on the Angers quince seedlings. The buds often fail to set. It is also difficult to secure all of the trees absolutely true to name. Sometimes 30 to 40 per cent of the so-called "Orange" trees may be Angers, of but little value.

Planting. One-year or two-year-old trees are usually planted. The nurseries train them as trees. They are better trained as bushes, although there is sometimes more trouble in hunting for borers when trained in this manner. Planting may be done in spring or fall; 15 by 15 feet is the common distance. The orchards may be cultivated and seeded to cover crops, but more often the trees are left in sod.

Pruning. Comparatively little pruning is given, although some growers practice systematic heading-in of the trees, removing half of the year's growth from the strong shoots during the winter months. Usually, however, the pruning given to control blight is adequate. Whether to practice annual heading-in or do practically no pruning will depend upon conditions and the way the bushes are growing. The method of fruit bud formation is unusual. These are not formed the season prior to bloom as in the apple and pear, but in spring the lateral buds on the previous year's growth send out new shoots and single blooms are borne on the tips of these when they are 3 to 6 inches long. If the bloom sets a fruit no more growth is made. If not, one of the lateral buds will usually start into growth and continue the branch for perhaps a foot or more. Where the bush is bearing regularly the growth made is short and the head becomes rounded and looks as though it might have been sheared. If little fruit is set the growth is apt to be longer and the bush looks more ragged. To maintain a supply of fruit-bearing wood an adequate growth must be secured from which fruit-bearing shoots may start and the center of the bush must not be permitted to become "blind" or lacking in new wood growth.

Fertilizers. The use of manure and fertilizers will depend to some extent on the trees themselves. They should not make too much wood growth, but if the trees are stunted some manure may be applied or an application of fertilizer made. Nitrate of soda is often used to advantage on trees in sod. Where tillage and good cover crops are grown, little manure is necessary.

Spraying. Spraying is of more importance than fertilizers. Bordeaux mixture, 3:3:50 or 4:5:50, is the best fungicide. Arsenate of lead is the leading arsenical poison. Three sprayings are usually given, one just before the blossoms open, one for curculio and codling moth when the blossoms fall, and a third a month later. A fourth spraying is sometimes, one might say generally, profitable when the fruit is two-thirds grown. Spraying, with most fruits, is one of the expenses on which it does not pay to economize.

Quince troubles. San José scale seldom attacks the quince It may be neglected. Borers will have to be hunted twice a year, usually in May and June, and again in September or October. The codling moth and the quince curculio will be combatted as directed for apples. The latter is difficult to handle. Spraying with 3 pounds arsenate of lead paste to 50 gallons of water or its equivalent, making two applications at ten-day intervals when the beetles appear may be helpful. Fire blight is controlled by cutting out the diseased wood as outlined under pears, disinfecting the cut surface with cyanide of mercury 1 to 500 and removing wild trees such as hawthorn, which may carry the disease.

Black spot of the quince (*Fabrœa maculata*) is a fungus disease which attacks the fruit and foliage, causing the black spots on the fruits, and the leaves to fall prematurely. It also attacks the pear. Bordeaux mixture will usually control it, sprayings being made before the blossoms open and as soon as they fall. Arsenate of lead may be combined with bordeaux mixture to control the codling moth and curculio. Two or three sprayings may be given later in the season. Some advise the use of lime sulphur 1:40 with 3 pounds iron sulphate to 100 gallons of the mixture.

Quince rust (cedar rust). This disease attacks the quince as well as the apple. Get rid of the cedars.

Winter killing. Small and even large-sized bushes often are winter-killed. In some regions a temperature of 14 degrees below zero will destroy a plantation, while in others a temperature of 20 degrees below zero will not cause any trouble. Humidity plays an important part. Mice frequently girdle the quince trees. (See Apple.)

Harvesting. The fruit is ready to harvest as soon as it has good color. It should be picked carefully. If bruised, the bruised area soon becomes dark brown and spoils the appearance of the fruit. Padded half-bushel, drop-handle, picking baskets are usually used for picking.

Grading and packing. Some growers grade into three sizes and rub the fuzz off the fruit to make it more attractive. In some cases it is packed in barrels the same as apples. Half-barrels or even bushel kegs may be used. The best grades are frequently packed in peck-size grape baskets. All fruit marked "fancy" should be free from all defects such as scab. curculio injury and should be of one variety. It goes without saying that it be well matured and properly packed, and of the size designated.

Packing the barrel. In packing a barrel, the face is plated with selected fruit as with the apple, except that the calyx end is shown, not the stem end as in the apple. A bruised quince is ruined. When handled roughly, the bruises show in the course of a few days and the fruit is unsightly. The barrel must be well racked and not pressed as tight as apples for export. Fruit pressed too hard does not keep. When sent for immediate sale, there is no need to press tightly. However, the fruit must not rattle or be free to move during transit.

Storage. The fruit is usually sold in the fall. Some fruit is held over to January and February in common storage or cold storage. Some growers maintain that a steady temperature of 35 or 36° F. is better than lower; others prefer 40° F. The fruit is apt to scald in storage. For a time the scald affects the skin only, but it soon penetrates the flesh and causes it to break down and lose flavor. Green fruit of a certain degree of maturity scalds before properly matured fruit. In storage the fruit is apt to be attacked by a soft rot which causes a rapid decay of the cells. Fruit badly attacked by scab may not keep well. Overripe fruit has a short storage life. Fruit which has been in storage is apt to sweat when brought into a warm room, and may decay rapidly if the package is kept tightly closed. Ventilated barrels are of value in such a case. If the barrels are to be held at a temperature of 60° F. to ripen the fruit as is sometimes necessary, the heads should be taken out of the barrel to prevent sweating and subsequent decay of the fruit.

Yield. The average yield per tree per year is about 12 quarts. The yield per tree may reach a bushel when in full bearing; some good trees produce two bushels. A few fruits are borne at from six to eight years after planting and in about ten years the bushes may be expected to be of full size. They live thirty or forty years. The bulk of the crop is used for baking and making into jelly and jam. A small amount is canned.

PART II

DRUPE FRUITS

CHAPTER XXXIV

THE APRICOT

The apricots (*Prunus spp.*) grown in the United States are natives of China or Japan. There are three species:

1. The common apricots of Europe and America (*Prunus armeniaca*) which have red or yellow fruits, smooth skins when mature, sweet firm flesh, large, smooth flat stones, free or nearly so. The trees have round, spreading tops and a reddish, cherry-like or peach-like bark with ovate or round ovate, short-pointed leaves, often heart-shaped at the base. The flowers are borne single and come out before the leaves. The Russian apricots belong in this group, but are small-flowered species.

2. Japanese apricot (*Prunus mume*) is grown for its flowers rather than for its fruit, but owing to its resistance to crown gall it may be valuable as a root stock for apricots, Domestic and Japanese plums.

3. Purple or black apricot (*Prunus dasycarpa*) is but little cultivated.

The common apricot of Europe is, therefore, of first importance, and is largely grown in California, and to a limited extent in other parts of the United States.

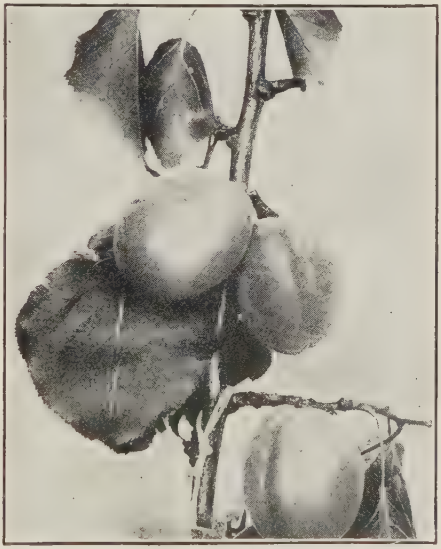

FIG. 80. Royal Apricot, fruiting branch self pollinated
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Distribution of production. Apricots are grown in California and to a small extent in Oregon, Washington, Idaho, Utah, Colorado, Arizona, New Mexico, Kansas and New York. However, 90 to 95 per cent of the commercial production is in California. In that state the fruit is grown in every county except six, and these are in the high Sierras. There is danger from frost if planted on an elevation above 1,200 feet. Because of its commercial importance, California commercial conditions are treated in this book, other states being compared with them.

The early fruit for eastern shipments is grown principally in the Imperial Valley, and at Winters in the Sacramento Valley. Later supplies are drawn from the Sacramento River region, the San Joaquin and Santa Clara Valleys. Fruit for canning is produced principally in the coastal valleys and the San Francisco Bay region, while the crops grown in the San Joaquin, Sacramento and other interior valleys are dried. The heaviest plantings are in the Santa Clara Valley, the Aromas Section ot Monterey County and in the so-called ''foothills'' surrounding the Pajaro Valley in Santa Cruz County. In Southern California, Riverside and Los Angeles counties lead.

Climate. Frost is the chief limiting factor in the production of apricots. The fruit is profitable only in regions where spring frosts do not kill the buds, bloom or young fruits; and where there is freedom from rains during the summer, for these encourage the brown rot which is a serious menace when the fruit is ripening.

Soils. The apricot grows best on a deep sandy loam and gravelly soils supplied with an adequate amount of moisture. It can be grown on soils containing a high percentage of clay and even on adobe soils. It is usually grown on the lighter soils because it is generally propagated on apricot and peach roots.

Stocks. The stocks used are apricot, peach and plum. A survey of California nurseries in 1919 showed that 49.1 per cent of the trees in the nurseries were on apricot roots, 27.2 per cent on peach and 23.7 per cent on myrobalan plum. The almond has been tried because of its ability to live under dry conditions, but the union is poor; the trees are apt to break off about the time they attain maturity. The apricot root has the disadvantage of being a favorite with certain rodents, but otherwise is a good ''all-round'' stock. The plum root is better adapted to soils too wet and heavy for either apricot or peach, but under certain conditions it stunts the apricot tree to such an extent as to render it undesirable. The peach is generally used as a stock in the East, where the pits are handled as outlined under the peach.

Planting. In California, late fall or early winter planting is practiced. The leaves are allowed to fall naturally before the tree is dug. The leaves start to grow early and planting is usually finished by March. Trees are usually sold by height in California, yearling trees being sized 2 to 3 feet, 3 to 4 feet, and 5 to 6 feet. A medium-sized tree is preferred by some growers. In the East, two-year-old trees are sold by caliper or thickness of the trunk (taken 2 inches above the bud) as well as by height. A common distance apart to plant is 24x24 feet, or 24x26 feet on deep moist soils. Moorpark and Royal would be better set 26 to 30 feet apart. As soon as possible after planting the tree should be whitewashed from top to bottom to protect from sunburn.

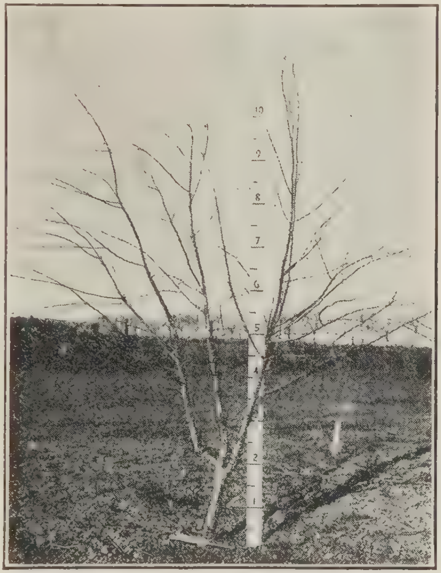

FIG. 81. Young apricot tree in California showing desirable head and the use of the long-pruning method in which the branches are not headed back. This method is coming into general use with almost all trees in commercial plantings.
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Pruning. Formerly the apricot tree was given considerable pruning, and annual shortening of the branches was practiced. Today the policy is being discarded. Pruning consists of the removal of unnecessary branches and twigs to ensure the maintenance of an adequate supply of fruit buds and leaves throughout the trees. Under this system the trees grow wider in spread and not so high. This method is becoming more general with most fruits. The trees are headed low, the tops cut off to about 30 inches from the ground and three or four branches arranged 6 inches apart, spirally on the trunk will constitute a desirable head; an open centered tree is preferred. In pruning large trees the average number pruned per day is about 25, or 40 for smaller trees.

The branches are shortened in when the tree is planted. After one year's growth the strongest growing branches are shortened back to secure balance; all may be shortened. Branches growing too vigorously may be pinched back during the growing season, and buds, starting where they are not wanted, may be rubbed off. Other than this no pruning should be given except when the tree is dormant. During the second year, where there is danger of the tree becoming too spreading in habit, and this is a danger, a cord is passed around the outside of the branches to hold them upright. The pruning given during the winter of the second season is to secure shape. The following year the trees set a considerable number of fruit buds and the third year a small crop is expected. From this time on, pruning consists of thinning out the wood so that the sun can reach all parts of the tree during some time in the day. The former method of heading in the growth reduced the yield 15 to 20 per cent annually. The vitality of the tree also was reduced. The grower soon learns which branches to remove to maintain vigorous growth. Trees five to six years old and bearing a full crop should make a twig growth at the ends of the main limbs of 12 to 20 inches annually; mature trees twelve to twenty years old

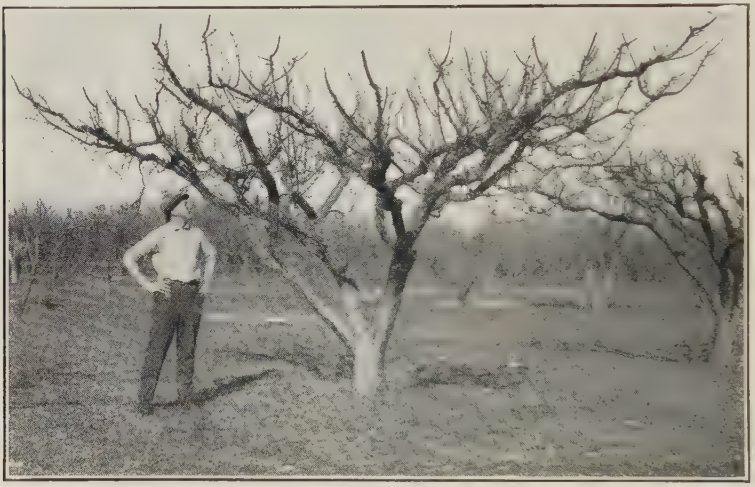

FIG. 82. Apricot tree in California showing the short pruning method in which the shoots are cut back each year to short stubs. Some peach and Kieffer pear growers in the East follow this method. In California with apricots it is being abandoned because it is costly and it reduces the yield often 20 per cent.

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should grow 8 to 10 inches and old trees forty or more years old may get along with 4 or 5 inches. Pruning may be used to correct over-bearing. Over-bearing may be due to too many branches in the tree, or to an inadequate supply of moisture. A thinning out of the branches may cause increased vigor in those remaining. In some cases it is profitable to thin out the shoots made during the prior season. In some cases these are topped when they set fruit, since fruit so situated is usually small, sunburnt and of little value. The best fruit is grown on spurs on strong, vigorous limbs as near as possible to the center of the tree, although fruit is borne on wood grown the season previous as well as on spurs on the two-year-old wood.

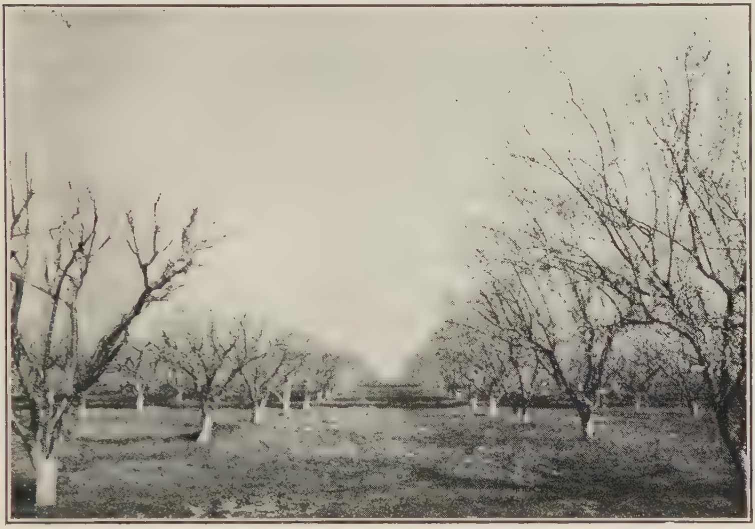

FIG. 83. Apricot trees of bearing size

Short pruned Long pruned

The increased amount of bearing surface on the latter is evident

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Cultivation. The methods followed in tillage, cover crops and irrigation where necessary are similar to those used for other fruits. If the winter rains penetrate the soil 5 or 6 feet deep, irrigation may not be needed. Young trees may be grown without irrigation, but irrigation often is profitable when the trees come into bearing. Sweet clover, bur clover, vetch, barley and rye are all used as cover crops. In a considerable portion of California irrigation is necessary. If the ground is not wet 6 feet deep by the winter rain, irrigation may be started in March or early April. If the ground is wet to a depth of 6 feet, irrigation may not be needed until May or June. If the trees are kept growing vigorously the water may be turned on about the time the fruit is ripening. Sometimes, an early summer irrigation is needed to secure size of fruit. An irrigation in early September aids in securing a good set of fruit buds for the next year. This must be done before the leaves fall. No fruit buds are formed after December. In regions of light rainfall, winter irrigation may be practiced to take the place of rain.

Propping and Bracing. Sometimes the trees need propping to carry their load of fruit. If the heads are formed of upright and not horizontal branches, it may be possible to use wire braces instead of props. Galvanized wire staples are driven into the wood, or screw eyes may be used if desired. A No. 14 galvanized wire is strung from each staple to a ring placed in about the center of the tree, drawn taut and made fast at both ends. In this way each limb is attached to the central ring. This system costs about $40 an acre and lasts the life of the tree, leaving the land free for work, which is important under irrigation.

Thinning. The fruit is shipped fresh, dried or canned. Size is of increasing importance. Canners do not wish fruit requiring more than 12 or 14 to make a pound, the smallest ever used is 16. The canners use the bulk of the crop. Formerly the driers paid the same price for all sizes of fruits; today the large sizes command a premium. The same tonnage can be secured from a thinned tree, with most of its crop averaging 12 to the pound as from the same tree, not thinned, with less than 25 per cent of its crop 12 to the pound and the balance 12 to 20 to the pound. Thinning begins in the middle of April before the pits get hard. The fruits are usually left 4 or 5 inches apart on a well-loaded tree. It is not profitable to thin doubles; where it is possible, both should be removed if there is danger of brown rot. On young trees, in districts where brown rot is not prevalent, clusters of three or even four fruits are allowed to remain.

Frost protection. With the exception of the almond and certain Japanese plums, the apricot is our earliest blooming deciduous fruit tree. It is apt to be injured by early frosts. The approximate temperatures which apricots are likely to endure for 30 minutes or less without being killed are: Buds closed but showing color, 27 to 30° F.; in full bloom, 28 to 31° F.; after fruit has set, 30 to 31° F. The heaters are usually lighted as soon as the temperature in the coldest part of the orchard reaches 31° F. With 75 to 100 of the "lard pail" type of heater per acre, about half of them are started at once, and if the temperature is not raised above the danger point in 20 to 30 minutes the balance are lighted. An active man will light from 200 to 300 an hour. It is easy on a still night to raise the temperature two to three degrees, and difficult to raise it more than four to five degrees. The coldest part of the night is usually before dawn, hence the heaters should be kept burning until after sunrise. Whether to purchase heaters or not will depend upon local conditions.

Insects and diseases. The injury of **the brown scale** (*Lecanium corni*) is indirect. The insect secretes a honeydew and on this a sooty fungus grows which blackens the surface of the fruit, rendering it undesirable for canning. It may be dried, but the product is not fancy. The insect is common along the coast, and is usually controlled by spraying in January or February with crude oil emulsion, distillate emulsion or miscible oil. A thorough spraying every two or three years usually is adequate. Similar treatment is given for the black scale.

The peach twig borer (*Anarsia lineatella*) attacks both young growing twigs and fruit, destroying the tips of the branches and weakening the trees. Control is to spray with lime sulphur 1 to 10 and arsenate of lead as the buds begin to open in the spring; bearing trees are sprayed as the trees come into bloom, which aids in control of brown rot as well.

California Peach Borer (*Ægeria opalescens*) attacks the tree just below the ground. It is very common on the peach along the coast in California. Dig out the borers in fall or winter and seal the wound with hard asphaltum of the grade known as S-Flotine. Apply it hot. Oronite roofing paint, used cold, may also be used. Some recommend coating the crown of the tree for 5 or 8 inches below ground to the main roots and 4 or 5 inches of the trunk above ground with oronite, applied annually or the asphaltum applied every two years. Paradichlorobenzine applied in fall three-fourths to one ounce to a tree appears to be the best treatment. See Peach.

Flat-headed Apple Tree Borer (*Chrysobothris femorata*) seldom attacks healthy trees. Keep the trees growing vigorously.

Shot-hole Fungus (*Coryneum beijerinckii*) attacks fruit, leaves and twigs, and kills the buds. The tips of the twigs may die back in spring. The leaves show perforations. Young growing twigs in spring may show gumming, which may be taken for brown rot. Control is to spray in fall and spring with bordeaux, 4:5:50; lime sulphur, 1 to 10; or dry lime sulphur, 12 to 50. The fall spray is applied in November or early December when the fall rains have begun and again in spring as the buds are swelling. Some orchardists wait until the blossoms begin to open and use lime sulphur to control brown rot and twig borers at the same time.

Brown Rot (*Sclerotinia cinerea*) is one of the most serious diseases, especially in certain regions along the coast in California and even inland. Fruits, blossoms, fruit spurs, twigs and branches may be attacked, although in the latter case the disease usually enters through a fruit spur. No spray has yet been devised for preventing the disease from attacking the ripe fruit. Sulphur sprays cause ''sulphur sickness'' to apricot trees, when applied after the fruit has set, injuring both fruit and leaves. Bordeaux mixture may not injure the fruit but it burns the foliage. The treatment suggested is to cut out all diseased wood and cankers in the fall, and to apply bordeaux mixture, 7:8:50, at the time the fruit buds show, and again as they open, and even until they are in full bloom. Unless done on time, infection of the open blooms may take place before the spray is applied. Collect and bury or burn the mummied fruits. In susceptible orchards, the fruit may be sprayed with bordeaux mixture, 4:4:50, up to a month before the fruit matures.

Oak Fungus (*Armillaria mellea*) attacks apricot trees on any root stock upon which they may be grown. In California it does not attack the Northern California black walnut, pears on French and some other stocks and figs, but attacks all other deciduous fruit trees. It spreads from root to root. It is recognized by the mushroom odor of the diseased tree and by the presence of the mushrooms at the base of the tree. The remedy is to construct a barrier 3½ to 6½ feet deep around and two rows of trees beyond the infected area, as a ditch or a concrete wall, and irrigate same heavily to cause the roots to decay; or plant to alfalfa or other crop not subject to the disease for a term of years.

Bacterial Gummosis (*Pseudomonas cerasus*) is a bacterial disease that gives light amber or yellowish gum. Inspection reveals a cavity beneath the bark. The disease attacks the trunk, branches and twigs. It is spread by pruning tools unless disinfected by swabbing with bichloride of mercury, 1 to 500 of water. To control, cut out the cankers and gum, swab the wound with 1 to 500 of bichloride of mercury and cyanide of mercury in glycerine and water 3:1, and paint with oronite.

Black Heart (*Verticillium sp.*) is a fungus disease which causes the branches to die in early summer. It is most prevalent on trees coming into bearing, three to five years old, but will attack older trees. The heart wood shows black, or an outer ring of the heart is darker than the remainder. Cut back to healthy wood and give the tree a chance to recover.

Crown Gall (*Bacterium tumefaciens*) seldom kills the tree, but reduces the vitality. Borers in the galls spread the infection. Remove the galls with a chisel, paint with copper sulphate solution and cover the wound with oronite.

Sour Sap is seen among trees on "hardpan" or "waterlogged" soils, also on gravelly spots which are short of water. The sap of the tree ferments and gives off a characteristic odor. Extremes of temperature in late winter and early spring seem to be a common cause. Trees which failed to mature their wood properly are most easily hurt. Whitewash the trees in December to reflect the heat. Maintain a uniform water supply by drainage and irrigation where needed. Topwork immune seedlings in the branches or trunk using myrobalan, mazzard and morello cherry, bitter almond, peach where found adapted.

Green Rot (*Sclerotinia libertiana*) is the blossom or calyx rot and sometimes known as jacket rot. The disease attacks the fruit a week or two after the blossoms fall, during foggy or rainy weather. The spores lodge under the "shucks" or "jackets" and germinate, and cause decay and the fruits to drop. Spraying as for brown rot is suggested.

Harvesting. The use to which the fruit is to be put influences the time of harvest. For shipment to eastern markets, fresh, both color and size are considered. The undercolor should be turning yellow, or straw colored. Often fruit is picked too green, and such is not of good quality. The time of harvest depends upon the variety, and extends over several weeks. In the Sacramento Valley the average harvesting dates of certain varieties are as follows: Newcastle Early, from June 1 to June 10; Royal, June 1 to 20; Blenheim, June 12 to 30; Tilton, June 15 to 30; Peach, June 20 to 30, and Moorpark, June 25 to July 10.

Method of harvesting. The fruit is gathered by hand with the stem attached. It should be separated from the spur by a slight twist or upward turn, not jerked or pulled, for this tears and breaks the skin, which may lead to decay. The branch may be held by one hand and the fruit held in the other. The fruit is gathered in ten- or twelve-quart tin pails or in picking baskets. Some prefer the pails. They are smooth, do not scratch the fruit, and if fruit is dropped into them it can be heard, but fruit should be laid in the pail, not dropped. A hook is attached to the pail or basket for hanging on the tree or ladder. A three-legged ladder is used to stand on. The fruit is emptied from the pail into lug boxes which hold about 40 pounds of fruit. These measure inside 22 inches long, 12 inches wide, 7½ inches deep. An inch cleat is nailed on the ends to raise them above the sides so that the full boxes can be piled on top of one another. The lug boxes should not be filled over 6 inches deep and should be kept in the shade while waiting to be hauled in. Harvesting is usually paid for by the hour. The pickers each should gather 900 to 1,500 pounds of fruit per day. Three to five pickings may be necessary.

Harvesting for canning purposes. Canners require the fruit ripe but firm. Blenheim and Royal apricots must be yellow and may or may not have a blush on the side. Tilton may be yellow on one side and still be too green. The fruit must be in exactly the right condition. The canner desires uniformity in size. It may be 12 to the pound or 14 or 16 may be satisfactory. Smaller fruit often is dried or used otherwise.

Harvesting for drying. Hand-picking is desirable, since bruised fruit does not make a first-class dried product. The fruit is sometimes shaken off or knocked off by means of poles. It should be riper than for the canner or for shipping fresh, but it should be firm ripe. If too ripe, the product is apt to be dark colored.

Drying. The fruit is slit, the pit removed and the halves, cup side up, are laid on trays. These are stacked on trucks and wheeled into the bleaching house, where they are exposed to the fumes of burning sulphur for three hours. The sulphuring gives the fruit a yellow color, shortens the drying period, prevents decomposition, and affords protection from insects while in storage. The fruit is dried in the sun for two days; then for two or three days more in the shade; and then stored in lug boxes until needed. Five pounds of fresh fruit will make one pound of dry. A good yield is 1¼ tons of dry fruit per acre, three-quarters of a ton is nearer the average.

Apricots used in various forms. *The California Fruit News* gives the following data for the years 1915-20:

Year	Canned, cases	Dried tons	Fresh, cars
1915	981,190	19,500	329.25
1916	1,327,770	11,000	289.5
1917	2,356,553	15,500	403
1918	2,233,314	15,000	440.75
1919	4,395,204	15,500	419.5
1920	3,312,020	10,000	Est. 312.0

Packing and loading in cars. The fruit is sized, often wrapped and packed in 5-pound baskets. Four baskets make a crate. The fruit in a package is not to vary over one-eighth inch in size and must be free from the effects of insects and diseases. The crates are loaded five wide across the end of the car, and nine or ten tiers high. A carload is 1,000 crates. These crates are held in place by strips, and well braced in the doorway. The same package and method of loading is used as for plums.

Costs of production. The Division of Farm Management at the University of California gives the following figures based on pre-war conditions:

	Per acre
Value of land:	
High, (with water)	$400.
Low, (with water)	150.
Usual, (with water)	200.
Developed orchards:	
High producing	1,200.
Usual producing	800.
Cost of establishing orchards:	
Clearing, grading and levelling land for planting ($10 to $75)	20.
Trees at 20 cents (price in 1920 higher, 50 cents up)	15.
Setting out, $4 to $8	5.
Replanting	1.50

Cost of Maintenance, to bearing age, with crops grown between the trees:	Per acre
Cultivating	6.00
Irrigating $2 to $12	6.00
Pruning	3.00

Bearing orchards. Cultivation costs vary from $8 to $20 an acre. Pruning, pre-war price of $12 per acre rose to $35. A common price is 50 cents per tree. Costs of irrigation vary up to $30 to $35 an acre per application. Spraying in 1921 cost $15 per acre per application, or 3½ cents per gallon, on contract. Thinning cost $5 to $15 per acre. Digging out borers cost $3 to $5 per acre. Costs of oil in 1921 for heaters varied from $8 to $20 per acre. Cost of picking fruit $10 to $15 per ton in 1921 (green fruit); the pre-war price was $3 to $6. Cost of cutting for drying is 10 to 12 cents per box. In 1916 the cost of drying varied from $35 to $50 per dry ton. In 1920 it cost from $90 to $100 per ton. For drying a crop of 50 tons, the equipment needed is 300 lug boxes and 800 to 1,000 trays, 3x8 feet size. Lug boxes cost 20 to 30 cents each. Trays cost 80 to 90 cents each.

The apricot in the East. Where peaches can be grown, the apricot may be planted for home use, and occasionally it is grown commercially. Usually it is planted on a strong loam which is fairly rich, deep, and well drained. The best commercial results are secured when the orchard is in proximity to a body of water, where spring frosts are not apt to be serious. The chief danger is early frost. For tillage and cover crops the usual course is to proceed as outlined for the peach. Pruning is similar to that given the plum. The spraying given is that outlined as for the peach, which is subject to somewhat similar conditions.

Varieties in the East. The apricot is usually propagated on peach stock, although in certain cases plum stocks are used, both Myrobalan and Domestica, the latter being preferred. Among early-maturing varieties may be mentioned: Harris, St. Ambroise, Montgamet and Early Golden. Good mid-season varieties are Moorpark and Peach. Common late varieties are Alex, Alexis and Budd. Royal and Superb are grown to a limited extent.

CHAPTER XXXV

THE CHERRY

The cherry (*Prunus spp.*) is grown in every state in the Union. The leading states in the production of this fruit are: California, New York, Michigan, Pennsylvania, Ohio and Indiana. The cultivated cherries are divided into types: (1) Sweet Cherry (*Prunus avium*) which are large, tall-growing trees, pyramidal in form, often living one hundred years; and (2) Sour Cherry (*Prunus cerasus*) low-growing, bush-like trees, never pyramidal in outline but carrying considerable foliage and living up to seventy years.

Sweet cherries are divided into two main groups: (1) Those with soft flesh as the French Geans or Heart Cherries of the English. (2) Those with firm flesh as the Bigarreau. Each of these is further sub-divided according to whether (a) the juice has little or no color, or (b) the juice is reddish or dark colored. Examples of light-colored heart varieties are: Coe, Ida, Elton, Waterloo and Wood; of dark-colored heart varieties, Black Tartarian, Early Purple and Eagle; of the light-colored Bigarreau, Napoleon and Yellow Spanish, and of the dark-colored Bigarreau, Bing, Windsor, Schmidt and Mezel.

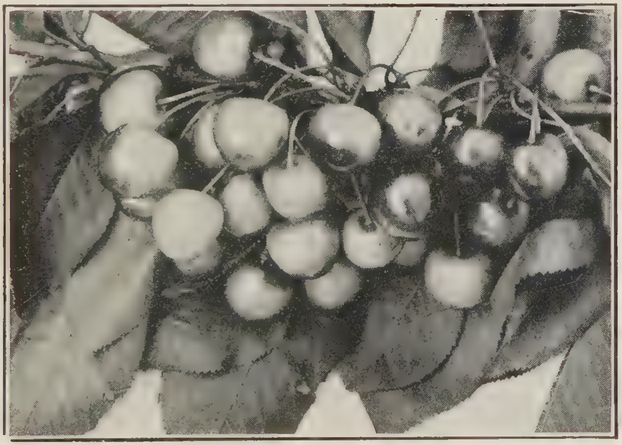


FIG. 84. Napoleon (Royal Ann) sweet cherries. The leading white variety

The sour cherries are in four groups: (1) The Amarelles or Montmorency group—the fruit with colorless juice, flesh whitish or red tinged, strong upright growers as Montmorency and Early Richmond. (2) The Morello group—the fruit with colored juice, flesh dark and dark-colored fruit, trees small and poor growers, with a drooping habit as English Morello and Louis Philippe. (3) The Brusseler Braune group—the fruit with juice highly colored, flesh dark red, fruit dark-colored. trees large, upright, compact, round-topped growers as Russian and German varieties. (4) The Vladimir group—the fruit with highly colored juice and dark-colored fruit, trees compact, with slender, willowy branches as Russian varieties.

The Duke Cherries are hybrids between sweet and sour cherries and the varieties show all grades of difference between the two. They are divided according to the color of the juice. Reine Hortense is an example of one with colorless juice and May Duke, an example of one with colored juice. Like many hybrids, the Duke cherries show a tendency to sterility. The pollen grains are usually shrunken and lack vigor.

The Sand Cherry (*Prunus besseyi*) has given rise to the Improved Dwarf Rocky Mountain Cherry and its hybrids with various plums, cherries, peaches and apricots. These hybrids open a new field of fruits for the Central West. The work of Professor Hansen of South Dakota in hybridising these plants has increased the list of fruits considerably.

The Padus Cherry is represented in Europe by the Bird Cherry (*Prunus padus*), and by the Choke Cherry (*Prunus virginiana*) in this country. The Choke Cherry is cultivated to some extent by the French Canadians and elsewhere and shows capacity for much improvement. Some of the fruits are half an inch in diameter and are eaten raw. They make good jellies, sauces and preserves, and are distilled in the manufacture of liqueurs. The fruits vary in size and color, some being yellowish-white. The trees are propagated from sprouts which start at the base of the tree. The tree may attain a height of 25 feet and will grow on a sticky blue impervious clay along the St. Lawrence River.

Soils for cherries. The sour cherry thrives on a diversity of soils. So long as the soil contains moisture it will grow in a dry climate and withstand heat or cold. It enjoys immunity to San José scale and is not so subject to insects and fungus diseases as the Sweet Cherry. The Sweet Cherry is quite fastidious as to soil. It demands a well-drained, deep, loam soil. It cannot tolerate an excess of moisture. It is easily injured by excess of heat or cold and is a prey to almost all the insects and diseases of stone fruits. The areas in which this fruit can be grown are limited but widely distributed.

Climate. Cherry climates are of more importance than cherry soils. Both, however, are necessary to success. Although the sour cherry is relatively hardy and blossoms rather late its blooms are sometimes caught by frost. The sweet cherry is much like the peach and needs coddling. It cannot endure as long a period of hot weather as the peach and demands a warm, sunny, genial, equable climate. Cold, wet weather at the time of bloom is injurious to all cherries. Wet, muggy weather at the time of ripening of the fruit encourages the brown rot. Too much rain as the fruit ripens causes it to crack. Cold, dry winds in winter will kill the sweet cherry tree on the western plains. Trees showing winter injury are usually more seriously injured than appears to be the case. This is especially true of sweet cherries. The Dukes as a class are intermediate between the sweets and the sours as to climatic and soil requirements, some leaning one way, some the other.

Regions well adapted to cherry growing. In Oregon, in the Willamette Valley and in the Cascades in Washington, the rainfall is abundant and the production of cherries has been made a special industry. In western New York the growing of sour cherries has developed in the last two decades to a marked extent. Orchards of 150 acres of solid cherries may be found. In Michigan a remarkable development has taken place; sweet cherries from Michigan have sold for higher prices on the Chicago market than those from the Pacific Coast. In California, the sweet cherry thrives in well-drained alluvial soils which are deep and moist, and where the atmosphere is not too dry. The cherry will not grow where the air is dry. It refuses to fruit. There is a heavy planting of sour cherries in the Mississippi Valley, so that on the whole the production of cherries is very well distributed.

The cherry thrives on a small water supply. The cherry, especially the sweet cherry, owing to its habit of producing its fruit by July, can be grown with much less rainfall than an apple, especially a winter apple. Sweet cherries can be produced on a 16-inch rainfall. All its growth is made in the early portion of the season; its fruit buds for the following year are made and its fruit is matured so that there is not the demand for moisture during the fall. In fact, where there is an excessive amount of moisture after the growing season is finished the tree suffers in proportion. Much of the trouble with sweet cherries is due to the fact that they are furnished an excessive amount of moisture and are therefore short-lived. In England the most successful growers keep their sweet cherry orchards in grass all the time.

Propagation. The cherry is propagated almost entirely by budding. In some instances root grafts on Mazzard roots are made. At the present time two stocks are in use—Mahaleb and Mazzard. The Mahaleb is in most common use. It is a dwarf-growing to medium-sized European cherry. For the Central West the Mahaleb stock is desirable, but there are other stocks suggested for use, as for instance, *Prunus besseyi*. In the East, Mahaleb stock is most generally used, although there are nurserymen who use Mazzard roots. The Mazzard is the native, black, sweet wild cherry. It makes a long-lived tree, and is sufficiently hardy for eastern conditions. It is, however, sometimes quite difficult to make the buds take. One year a good stand may be secured, but in another year, with just as promising conditions, not 40 per cent of the buds will unite and live through the winter. Unless higher prices are secured for cherry trees on Mazzard roots than is obtainable for those on Mahaleb there is no inducement for a nurseryman to grow them. The Mazzard root is much more fibrous and large trees on Mazzard roots can be transplanted. Trees up to ten years old can be moved just as easily as the apple, but this does not seem to be true of trees on Mahaleb. Growers who secure either sweet or sour cherries on Mazzard roots usually have little difficulty in making the trees live. Several reports show loss of no trees to less than 1 per cent for the first three years after setting. With trees on Mahaleb roots the loss may be expected to be higher. In the case of sweet cherries on Mahaleb roots it not infrequently happens that even if the trees grow when transplanted they begin to fail and finally die about the time the trees come into bearing.

The stocks for cherries. Previous to 1850 all cherries grown were propagated on the Mazzard root, the *Prunus avium* or the wild sweet cherry. About 1860, the Mahaleb, (*Prunus mahaleb*), introduced from France as stock to dwarf the cherry, came into general use for all purposes. By 1880 it was more popular than the Mazzard and today 95 per cent of all cherries grown are on Mahaleb roots. The Mahaleb cherry is adapted to a great diversity of soils. It is hardy and will withstand more heat and cold than any other stock. It is not subject to aphis, mildew or the shot-hole fungus in the nursery row and is easily budded by nurserymen. It ripens its wood early so that trees may be dug earlier in the fall. It is the better tree in the nursery.

Hardy roots. The Mahaleb stock tends to dwarf the tree as it gets mature, but this does not appear in the first few years. Trees come into bearing a little earlier on Mahaleb roots but the size of the fruit is not affected. The Mahaleb stock is better than the Mazzard for sandy, stony, dry soils or shallow soils not well suited to cherry-growing. The Mahaleb is held to be hardier than the Mazzard because it ripens its wood earlier in the fall. Those desiring a hardy root may use one of the Russian cherries, as Brusseler Braune, Bessarabian, Ostheim or English Morello, all of which come fairly true from seed. In Canada the Pigeon Cherry (*Prunus pennsylvanica*) is used as a hardy stock, but it tends to dwarf trees markedly and to sucker badly. In the West and Northwest the Sand Cherry (*Prunus pumila*) is used for cold, dry regions for the Sour Cherries.

The Mazzard cherry makes a better union with the bud than the Mahaleb. Fruitgrowers in California, Oregon, Washington, Michigan and New York—all great cherry states—generally contend that varieties on Mazzard roots are more productive and profitable than those on Mahaleb roots. For Sweet Cherries it is the only stock to use.

Planting. The tendency is to plant the trees too close together. Many growers plant Montmorency 18 to 22 feet apart, the dwarfer-growing Morello at 16 to 18 feet and the sweet cherries at 24 to 30 feet. Wherever conditions are good for cherries the maximum distance given should be the minimum and a greater distance apart may be better. Sometimes sweet cherries are interplanted with English Morello. The planting is usually made in spring, but it should be done early before any buds start, otherwise wait until fall.

Age of tree to plant. In the Eastern states and in Canada the preference is for two-year-old trees. In the Western states on the Pacific Coast the preference is for one-year old trees.

This difference is probably due to the fact that on the Pacific Coast the climate is milder, the season longer, and under irrigation a much more rapid growth is secured, so that the one-year-old trees are plenty large enough for handling commercially. In the East sweet cherries on Mazzard root are handled to a considerable extent at one year old. Growers who like their trees to be low-headed prefer one-year-old sour cherry trees.

Pollination. In the East there does not seem to be any question as to the ability of each tree to pollenize itself, but on the Pacific Coast the work at the Oregon station indicates that many varieties of sweet cherries are not only self-sterile, but also intersterile. Bing, Lambert and Napoleon are practically incapable of fertilizing themselves and also are unable to pollenize each other. In 1922, out of 3,713 blossoms of each variety self-pollenized, from a half of one per cent to one per cent set fruit and when inter-pollinated two-fifths of one per cent set fruit. Norma and Coe gave the best results with Lambert and Napoleon; Elton was best for Bing; Black Republican, which is of value on account of its saleability, ranged from 30 to 40 per cent efficient for Napoleon, 33 to 48 per cent for Lambert and not over 10 per cent for Bing. Some of the sour cherries are capable of pollenizing some of the sweet cherries.

Pruning. A difference is made in pruning the sour cherry and the sweet cherry. The sour cherry falls into two distinct types of trees: one, and the most common, the central shaft or trunk is left; and upon this, branches are allowed to develop; probably ten or twelve main branches will be formed on a good-sized tree. In other districts an open center tree is preferred. To secure it, low-headed yearling trees are bought, the center is taken out about 18 to 24 inches from the ground; four or five limbs are allowed to develop and the tree trained in much the same way as a peach. Such trees are more easily harvested. In sweet cherries it is much more common to allow the whole of the trunk to remain and permit the branches to form on it at irregular intervals. When the young trees are planted, the leader and four or five branches are left. It is best not to shorten back. Avoid crotches. If two limbs of equal vigor start from one point, take one off. Care must be taken during the first two or three years to remove strong shoots which start from the dormant buds on the trunk at or near the surface of the ground. Unless removed they drain the energy from the tree.

Other than the removal of branches which are not needed, no pruning is necessary until the trees come into bearing. In Europe the mature cherry tree is heavily pruned. Trees are grown as espaliers on walls. The tendency with commercial growers in this country is to prune to restrict the size of the tree and maintain vigorous growth. Both sweet and sour cherries are headed back when they reach the desired height. Tall trees are too expensive to harvest. It is often better to break the branch at the desired height and let it stay in position for a year or two, rather than cut it off; it avoids the formation of suckers.

Cultivation. For the purpose of cultivation, sweet and sour cherries should never be planted together. In the East and Central West sour cherries need cultivation until July or August. They may then be seeded to cover crops. On the other hand, the sweet cherry may receive similar treatment until it is three or four years old, when the land is seeded to grass that there may be a crop on the land to utilize the moisture in the fall. If a sod cannot be maintained it is wise to sow fall crops of oats, wheat or rye to take up this moisture. A blue grass or timothy sod is very good.

Fertilizers. Sour cherries are usually fertilized more heavily than sweet cherries. Nitrate of soda is of value to stimulate growth when trees have a sickly, neglected appearance, or lack vigor. Sweet cherries usually grow rapidly enough and are deemed able to get along without much manure or fertilizers. If good yields are to be secured on sour cherries the trees must grow vigorously; that is, they must make a growth of 15 to 18 inches on their terminals, and if this is not secured by tillage and cover crops, fertilizers may be used to secure it. A strong terminal growth ensures a large number of spurs and these are necessary for a heavy yield.

Cherry diseases. Black knot is a common disease of cherry and plum trees, and more common upon those of the Morello type of cherry. It is due to a fungus (*Plowrightia morbosa*), the spores of which ripen during the winter and are scattered early in spring. They alight on the new growth and cause the formation of a new knot. It is controlled by cutting out the diseased portion before March 1 each year and spraying the trees with bordeaux mixture. Be sure to burn the affected prunings. The disease occurs on wild cherries in the Northwest and these may serve as sources of infection.

Brown rot (*Sclerotinia cinerea*). This disease attacks the cherry in common with other stone fruits. For a time it made the growing of cherries precarious. Until recently it was not uncommon to see a beautiful crop of cherries one day and two days later, if the weather was moist or wet, to find the fruit infested with brown spots which gradually developed over the whole of the fruit. Sweet cherries are more easily injured by brown rot than sours. Dusting with sulphur or spraying with lime sulphur, 1 to 50, on cherry foliage and fruit is a satisfactory method of control. Applying sulphur dust a few days before harvesting reduces loss after harvesting.

Black Cherry Twig Blight. It is found growing on wild cherries in Western New York.

Cherry gummosis. The term gummosis is used to cover a multitude of troubles. The exudation of gum from a cherry tree may be due to several causes—to an insect attack, bacterial disease, brown rot or to mechanical injury. The tendency to form gum pockets is found on plums, apricots, peaches and other stone fruits as well as cherries. Citrus fruits and others show similar conditions. The sweet cherry is much more apt to be affected than the sour. The disease is most serious in humid climates where an excessive supply of moisture tends to push the trees to their utmost growth. The development of gummosis is so serious that it often discourages orchardists from planting. In the dryer sections where the cherries grow with a minimum of rainfall the disease is scarcely ever heard of. The disease progresses rapidly in the spring, but its spread may be checked by removing the diseased wood round the cankers. Control is in line of maintaining the trees in good physical condition, the use of a resistant stock, trunk and scaffold limbs such as the Mazzard, and top-working.

Shot-hole Fungus (*Cylindrosporium padi*), Leaf Spot, Leaf Blight, or Yellow Leaf (*Coccomyces hiemalis* and *C. lutescens*) attack the foliage of the cherry, producing diseased spots in the leaves. These are controlled by spraying with weak bordeaux mixture or lime sulphur. Three or four sprayings may be necessary, beginning as soon as the fruit is free from the shuck and repeating at two- to three-week intervals. Lime sulphur and iron sulphate make a satisfactory spray and dusting with sulphur or copper sulphate-lime dust is effective.

Powdery Mildew (*Podosphæra oxyacanthæ*) is common on nursery stock and sometimes on the older trees. Dusting with sulphur or spraying with lime sulphur to which iron sulphate is added is advised, using 3 pounds of iron sulphate to 50 gallons of water in addition to 1 gallon of lime sulphur.

Root Gall. It is usually advised that young trees showing galls on the roots or crown should not be planted.

Cherry insects. **The Cherry Fruit-flies** (*Rhagoletis cingulata* and *R. fausta*) and the Plum Curculio, all cause wormy cherries. The mature insects lay their eggs on the newly formed fruits; these hatch and the grubs burrow in. The fruit maggot is controlled by spraying with a sweetened arsenical poison as for apple maggot, the curculio by spraying or dusting the young fruit with arsenate of lead as soon as the fruit is well formed. The grub of the curculio is white, footless, with a brownish horny head; the grub of the fruit-fly is a white maggot, like that of a housefly. These pupate in the ground. Poultry in the orchard destroy many of them.

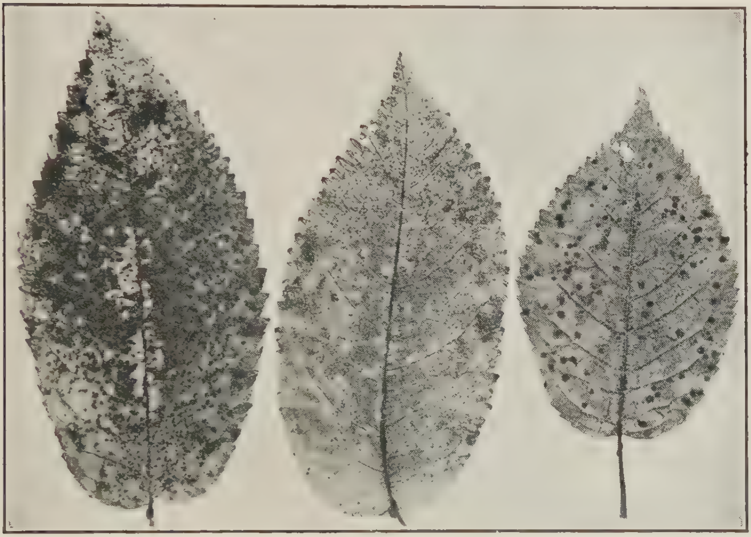


FIG. 85. Leaf bright (yellow leaf or leaf spot) on sweet cherry. The outside leaves show the upper and under surfaces. The center shows the whitish masses or spores

Cherry-leaf Beetle is an oval reddish beetle, a quarter of an inch long. It eats the foliage. Spraying with arsenate of lead will control it.

San José Scale, the Lecanium and a number of other scale insects attack the trees and fruit. ((See Apple and Peach.)

The Apple and Peach and Shot-hole Borers attack both sweet and sour cherries. (See Peach.)

The Pear and Cherry Slug. This eats the foliage and is easily controlled by spraying with arsenate of lead or dusting the foliage with any dust; even road dust or lime will do.

The Rose Chafer is controlled by spraying with molasses and arsenate of lead and destruction of their breeding places by tillage.

The Cherry Plant-louse or Black Aphis (*Myzus cerasi*) frequently attacks the sweet cherry. Spraying with nicotine sulphate with a liberal addition of soap as soon as the pests appear will destroy them and avoid stunting of the twig that is bound to occur if the precaution be neglected. Nicotine dusts are effective. (See Apple.)

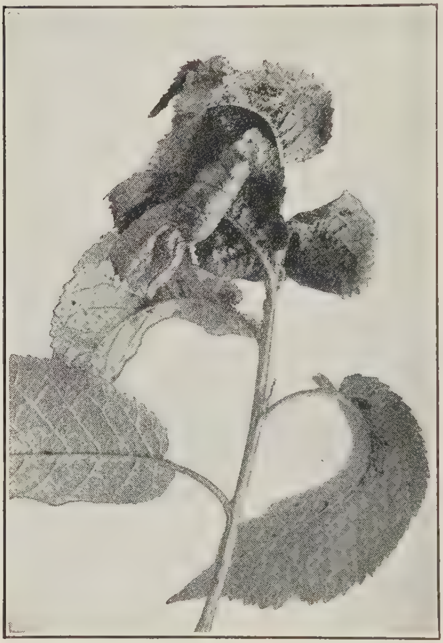


Fig. 86. The Black Aphis on Sweet Cherry

Spraying program. Omit any spraying if pests are known to be absent.

1. Dormant Spray. In spring before buds start, use lime sulphur, 1 gallon of concentrated solution 32° Baumé to 8 gallons of water for scale and fungus diseases. Usually omitted on sour varieties.

2. Aphis and Curculio Spray—as soon as petals fall. Lime sulphur, 1 gallon to 50 of water for leaf spot with "Black Leaf 40" or other standard nicotine spray; one-half to three-fourths pint to 50 gallons for aphis; add arsenate of lead 1½ pounds powder to 50 gallons for curculio, leaf beetle and slugs, or dust with 90:10 sulphur-arsenate of lead and nicotine.

3. Brown rot spray. When fruit is the size of a pea, spray as in No. 2. If Fruit-fly is present, and it is usually worse on late sour varieties, apply in a coarse spray on lower limbs of tree a mixture of 3 pounds arsenate of lead and 1 pint molasses to 50 gallons water when adults appear, usually early to mid-June in New York.

4. Leaf spot spray. Use soon after fruit is picked. Lime sulphur alone, 1 gallon to 50 of water to save foliage from leaf-spot and shot-hole fungus. Repeat a month later if necessary. If powdery mildew is prevalent add iron sulphate, 3 pounds to 50 gallons of above spray. Dusting with copper-sulphate-lime, sulphur and arsenate of lead, 90:10, or sulphur alone, may be used instead of spraying.

Harvesting. Fruit sold to nearby canners is allowed to hang until ripe. That which is to be shipped must be harvested earlier and with more care. Sour cherries for delivery to canners and juice makers are often pulled off, the stems being left on the trees. It saves the canner the cost of stemming, but the fruit must be used quickly or it will spoil. Grape baskets holding 6 or 8 pounds are used in harvesting and bushel and half-bushel baskets for delivering such fruit. For shipment the stems must be on the fruit. Sour cherries may be picked by hand or sheared off. In the latter case they may be gathered as clipped or allowed to fall onto a sheet spread under the tree. Fancy sweet cherries are picked by hand. The picker takes hold of the stem, not the fruit; and the following year's fruit buds must not be pulled off at the same time. A ten-quart metal pail with a hook on the bail is used to pick in. The fruit is hauled to the packing-plant as soon as possible after picking. Fancy dessert fruit must be handled with the greatest care at all times. A cherry which drops has no value.

Yield. The average yield per tree is just over a third of a bushel and its average value in the pre-war period was about 61 cents or an average price of 5.5 cents per quart to the grower. The Oregon Station states that 500 to 800 pounds of cherries have been grown on a single tree in that state. In California, 1,000 pounds have been yielded per tree. In Western New York three to four tons are considered a good yield per acre and nine tons have been secured.

Packing. The packing-house is usually equipped with tables or frames equipped with canvas bottoms on which the fruit is poured to aid in sorting before packing. The fruit which goes to the canning factory is not sorted; it goes as it is picked. Sour cherries are usually shipped as picked.

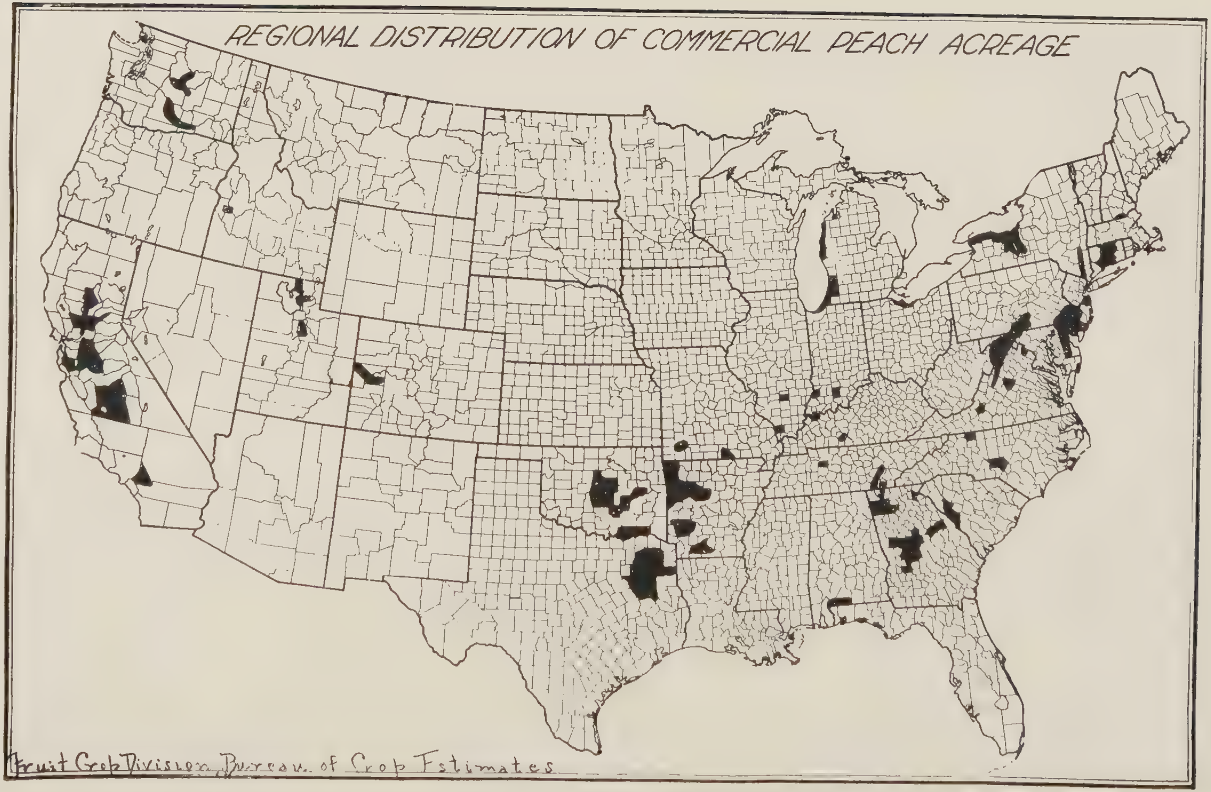
The Western sweet cherry is always packed in eight or ten-pound boxes for the eastern market. This size makes an ideal package. The four-pound climax basket makes an excellent package for the eastern trade. The Pacific Coast cherries attain large size, and even the canners fix grades. Fancy fruit must be at least seven-eighths of an inch in diameter and No. 1 fruit three-fourths of an inch. The Michigan growers have adopted two grades—the fruit shall be well ripened, and shall be picked at the proper time for shipment. The fruit must be graded, packed and delivered to the point of shipment by the grower. Boxes must be well filled and cases must be of standard weight for the variety. In all grades boxes must be free from sticks, leaves, stones, etc.

In shipping to markets in the East, the fruit is gathered with the stem on and is often shipped in quart baskets with 16, 24 or 32 quarts to the crate, or in climax baskets of various sizes, as the market demands. No effort is made to face the sour cherries. The sweet cherries may be shipped in the same package but more often a six-or eight-pound basket is used. The upper layer is faced with the stems down. The Jumbo Climax basket, holding 12 quarts, with a slat cover, is a very attractive package. The Diamond or Splint basket is unsatisfactory. The 4-quart Climax is useful on certain markets.

Eastern grown sweet cherries are usually not so firm in texture as those grown in California. The openings in the eastern markets for high-class fruit have not yet been supplied and the trade is capable of considerable extension.

Cold storage cherries, such as New York grown Montmorency, may be held in storage a couple of weeks if carefully handled. Some of the sweet cherries may be held longer. With pre-cooling and refrigeration this crop can be distributed over a much wider territory than it now covers. The western grown fruit is sent East and if properly handled eastern fruit can be sent West. Cherries are sometimes frozen at zero or below and then held frozen until needed for use in cooking. For this purpose they are usually stored near where they are to be used. They may be pitted and stored in cold storage in barrels, pails, tubs or paraffined cardboard containers, with or without sugar.

Selling. The custom is to sell cherries f.o.b or consign to a commission house. The bulk of the cherries are grown for the canning trade, and to supply this trade is foremost in the minds of most growers. It involves little expense in packing and shipping and is a safe market, even though the price is low.



REGIONAL DISTRIBUTION OF COMMERCIAL PEACH ACREAGE

Fruit Crop Division, Bureau of Crop Estimates

FIG. 87

CHAPTER XXXVI

THE PEACH

The peach- (*Prunus spp.*) growing area of the United States is not dissimilar from that of the commercial apple except that it does not reach quite so far north and extends a little further south. Wherever the temperature falls regularly to 20 degrees below zero in the winter, peach-growing is not a success save that a few trees may be planted for home use and given winter protection. During certain seasons and in certain regions a temperature of 5 degrees below zero will be as serious as 20 degrees elsewhere. The crop is grown to some extent in every state in the Union. It is a national American fruit.

Leading commercial areas. The leading commercial peach-growing areas are: (1) Central California on the Pacific Coast with some interest in Washington, Oregon, Utah and Colorado, California producing two-fifths of the commercial crop. (2) Maryland, Delaware and Southern New Jersey constitute an important group. (3) Georgia, Arkansas and Texas lead in the South, followed by Alabama, Oklahoma, North and South Carolina, Tennessee and Kentucky. (4) Missouri, Southern Illinois and Indiana form another group. (5) Connecticut, New York, Michigan and Ohio are the principal Northern states.

Climate. Local climate is the most important factor. Thus the peach region of Michigan, the island section in Sandusky Bay, Ohio and the northwestern counties of New York bordering Lake Ontario all are important peach-growing regions because of the modifying influence of the lakes. Near to the Great Lakes is a belt in which the winter temperature has been no lower than 9 to 13° F. in thirteen winters out of fifteen. At intervals it may go lower with disastrous results to the fruit as in 1917-18, 1903-04, 1898-99, 1895-96, 1884-85, 1876-77, 1858-59, or seven cold winters out of sixty.

The climatic conditions of the Delaware-Maryland peninsula and Southern New Jersey and of Connecticut along Long Island Sound are modified by the presence of the ocean. The location of orchards in favorable spots on foothills of the Blue Ridge in West Virginia, and on hillsides in Arkansas, Tennessee, North Carolina and other states illustrate the same consideration of climate. In Southern New Jersey an orchard located at an elevation of 100 feet above sea level is more consistently productive than one at a lower elevation and in Northern New Jersey one is more certain of a crop if located at not less than 500 feet above sea level. The location of the industry in Central California and in the irrigated valleys of the Western states illustrates again the search for a climate in which the tree will live and a site upon which it will thrive. Regions subject to high winds during periods of low temperature are unsuitable. Zero weather and a forty-mile wind for all day will be more destructive than a lower temperature on a still night for a short time.

The condition of the trees and the soil, the character of the season preceding the winter and the variety of the trees will determine whether they will endure severe weather. These need to be considered if one is examining a locality with a view to planting an orchard. In the northern peach-growing regions the planter needs to know not only the facts in regard to the winter climate, but also the length of the growing season, the dates of late frosts in spring and early frosts in fall, and the time of bloom and period of ripening.

Exposure. Some growers prefer a northern, others a southern exposure. While the average of a number of opinions as to which slope is best would probably show that each one had its supporters, it would probably merely emphasize what has been already pointed out that local climatic conditions must be known. If the western slope of a north and south valley is a week later in its period of bloom of trees and its wheat harvest than is the eastern slope, and it has been proven that peaches develop more crops on the western slope than on the eastern, then such information is of value. A moderate slope is preferable to a steep one because it is easier to work.

Soils. A variety of soils is in use. In the northern regions a sandy loam soil is preferred; one which will grow a good crop of potatoes every year and which is well drained. It is perhaps better to have the soil a little poor than too rich. It is easier to feed the trees and control their growth than to check them if planted on land which stimulates too much wood growth. On the Atlantic Coast from New Jersey south where sandy soils predominate, the fertilizer bill is quite an annual drain unless one uses land underlain with marl, friable clay or a fairly retentive subsoil. In the hills of West Virginia, red shaly and black chert soils which appear to be little but broken stone are excellent peach soils. In the Central and South Atlantic states reddish clay and sandstone soils are in use. Many of the

Georgia soils are friable clay loams or sandy clay subsoils with a sandy loam top-soil. Impervious clay subsoils and shallow soils 18 to 30 inches deep, underlain by bed rock, are poor; they are too subject to the effect of the seasonal variation. Light sandy soils are too apt to dry out and they need too much feeding. The soil has a marked influence on the hardiness of the tree. It must be warm and dry enough in the northern regions to develop a tree of sufficient hardiness. Extreme dryness of the soil and extreme wetness reduce the vitality of the trees and induce winter killing.

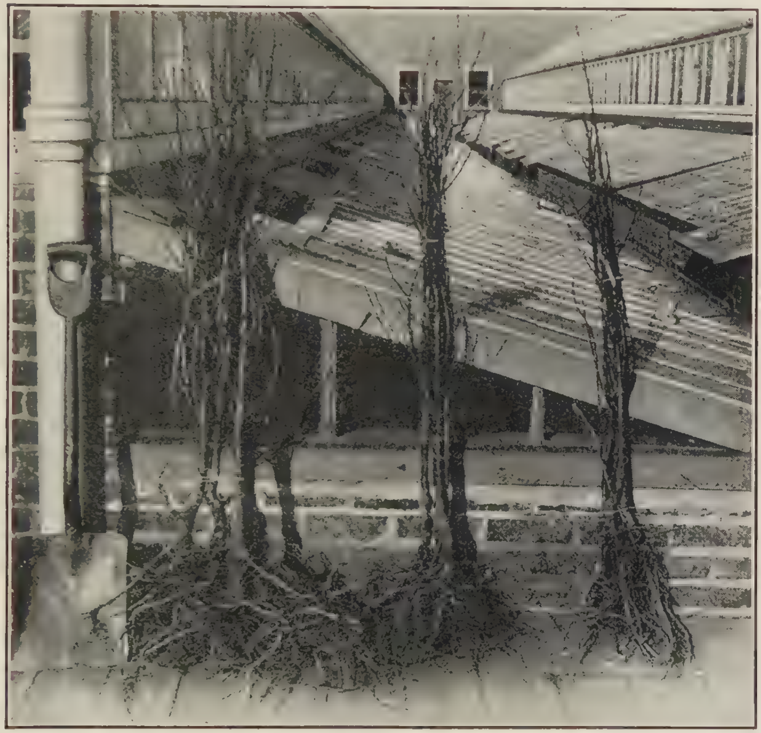


FIG. 88. Three sizes of peach trees, showing heavy, medium and light in size, all one-year old *U. S. D. A.*

Propagation. The different varieties are propagated by budding on seedlings, which may be transplanted or grown in the nursery row. The common way is to sow the seed. Pits from the wild peach trees of Tennessee and North and South Carolina are preferred because they are smaller, contain more twin seeds, are free from "yellows" and give a large percentage of vigorous seedlings. Pits from canning factories are larger and are, rightly or wrongly, not so highly esteemed by nurserymen. The common method is to hold the seed a year, planting it at the end of August with a planting machine in the nursery rows 40 inches apart, usually one seed every 2 inches. The seed may be held also in sawdust over winter and allowed to crack, and the kernels only being planted.

Budding. In the Northern states the seedlings are budded the following September and are grown the following season when they are dug and sold as yearling trees. In the South they are sometimes budded in June; the top is cut off as soon as the bud has taken and the bud makes a growth of a couple of feet or more. The tree is sold that fall or next spring as a "June bud."

Dwarf peach trees are obtained by budding on the Myrobalan plum or better still on the native American plum (*Prunus americana*) or on the dwarf western sand cherry (*Prunus besseyi*). These dwarfing roots are used for trees to go into pots, or to be grown to a form indoors.

Other stocks. The St. Julien Plum and Damson are sometimes used if the trees are to be grown on heavy land. On dry soils in California the hard-shelled sweet almond is used. Still another is David's Peach (*Prunus davidiana*), a native wild peach of China, where it is used as a stock. It may be used for the peach, nectarine, almond, apricot and plum and is sometimes used for the cherry. It is hardy, healthy, vigorous and resistant to drought. It has been used successfully in California and Texas where it withstands the heat. It is resistant to alkali and it has lived through a temperature of 40 degrees below zero in Minnesota. It may yet be one of the parents of a hardy race of peaches which will grow anywhere in the Eastern United States.

Variety is a local problem. It may cause complete failure in the business. For commercial use one requires few varieties and these to be consistently productive in unfavorable seasons; the fruit to be of large size, firm, well colored and a good shipper and favorably known on the market. For home use one may select a succession, and productivity will be second to quality. Whether the fruit will ship or not is of small moment.

In commercial orchards, in many parts of the country where the fruit is shipped fresh, we frequently find the same varieties. There is not the specialization of varieties for localities which is seen in apples. Hedrick in 1916 published a description of 2,181 varieties of peaches of which 181 varieties were obtainable and were grown. Elberta is the leading commercial peach everywhere in the East. The advent of Elberta made commercial peach-growing. The crop of Elbertas harvested and successfully marketed in 1899 laid the foundation for the peach business, especially in the South. It comes in mid-season. Greensboro, Carman, Champion and Belle are white flesh varieties which precede the Elberta, and Oldmixon Free is a standard white which follows it. St. John, Fitzgerald, Niagara and Early Crawford are yellow flesh varieties which precede Elberta and Crosby; Late Crawford, Kalamazoo, Chili, Smock and Salwey, named in order of maturity, ripen after Elberta. To these we may add Arp, Lola, Edgemont, Rochester, J. H. Hale and Frances.

For drying in California. Foster, Early and Late Crawford, Lovell, Muir and Salwey, in yellow freestones, and the Albright, McKevitt, Orange and Lemon clings with Levy, Phillips and Tuskena for the canneries. New varieties appear each year. A list of favorites of thirty or forty years ago might not have in it a single variety known now commercially.

Planting. The trees are planted various distances from 9x9 feet to 25x20 feet. A suitable distance for a beginner is 18x18 feet, or 20x20 feet. As with all other trees the important thing is to tamp the soil firmly around the roots. In the North the trees to be set should be wintered in the cellar. It is not safe to leave them out of doors hence spring planting is the only course. From Delaware, south, trees are often planted in late January and from that time on. The trees being small the planting crew should average sixty trees per day per man.

Pruning. The usual advice given is to cut the top off the peach tree leaving a stub of about 18 to 24 inches. A low-headed tree is advised. Those desiring a higher-headed tree may cut the top off higher and shorten the branches to three or four buds long, leaving three to five branches on the tree. If the low-headed tree is desired with a trunk 6 to 12 inches tall, it would be more easily secured if the low limbs were left on the tree in the nursery, but the custom has grown up of rubbing off the lowest buds as they start so that the head is formed at a height of 18 to 30 inches from the ground. The reason for this is that trees are sold by height as much as caliper. If a peach tree is 5 to 7 feet tall it is considered first-class by many purchasers. The fruitgrowers desire wood, and the nurseryman has tried to please a customer who does not know what he wants.

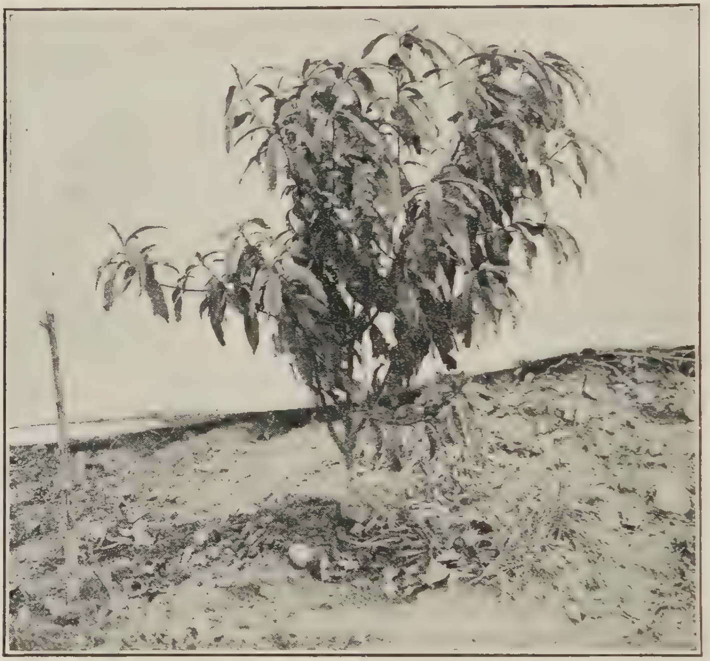


FIG. 89. Mayflower Peach Trees showing the manner of cutting off the head at about 15 inches from the ground, immediately after planting, also the growth made in the first five months after planting. Enough limbs started to enable one to make a fine head. Grown by Author, Geneseo, N. Y.

Leave limbs not shortened. If the limbs which are to constitute the tree are not cut back at all, merely removing those which are not needed, a better tree is secured than when the same limbs are cut back to stubs.

Pruning to form the head. All the branches are usually allowed to grow the first year. In that winter they are thinned out to three or four which become the main limbs of the tree. Some growers shorten in the limbs left in addition to removing all not desired; others practically leave unpruned the limbs which are to remain. The following year the tree receives little pruning and if it bears a few peaches so much the better if it is growing well. This will tend to check too much wood growth. It is not best to cut off all the small branches in the center of the tree; these bear the first peaches and give a crop the third or fourth year and nothing is gained by their removal; as soon as they have borne a crop they usually die. At the end of the fourth year it is often advisable to shorten-in the limbs to a branch going outward; in fact, when any pruning is done it should consist of spreading the tree, so that when it is loaded with fruit it spreads out like an inverted umbrella. The sun should get to all parts of the tree; no branch should shade another; the fruit will then be of good size and color.

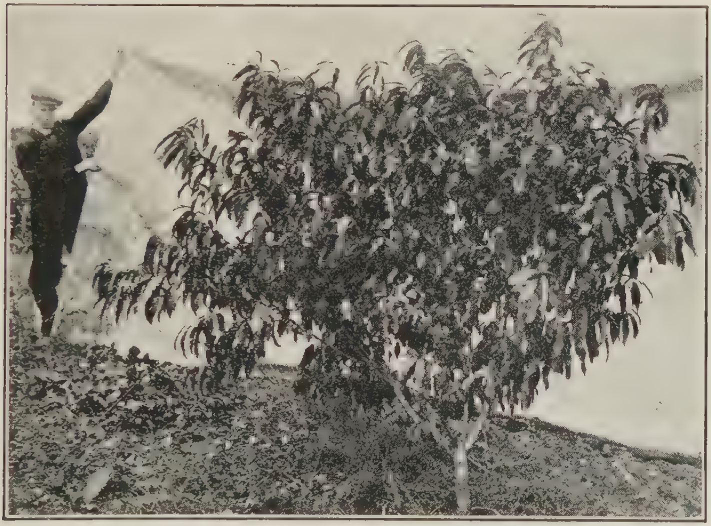


FIG. 90. Mayflower Peach Tree. Planted 17 months. Height 6 feet, diameter 8 feet. Grown by the author at Geneseo, N. Y. This is not an unusual development

Pruning the bearing peach tree. This usually consists of a certain amount of heading back or renewing of limbs by bringing in new wood from near the trunk and cutting out the limbs that get brittle. So long as the trunk is kept sound, the head may be renewed, although in regions where the peach tree is short-lived, it will not pay to do it. Whenever a peach tree lives but ten years it is short-lived. Some growers practice a system of gradual renewal, beginning when the tree is seven or eight years old to head back a limb, causing it to send out strong new shoots, one of which is taken in hand and made into a new branch. If skilfully done this is possible under certain conditions. A peach tree needs to be in good condition to withstand heavy pruning.

Shearing the Tree. In the Island section of Ohio several growers practically shear the trees, making them flat-topped. Each year the growth is cut back a half or more and new branches are brought in from time to time to replace those cut off. Where trees live twenty or more years more of this work can be done than where they are short-lived, from ten to twelve years. In the latter case it does not pay to head back the tree. It is best to pull it out.

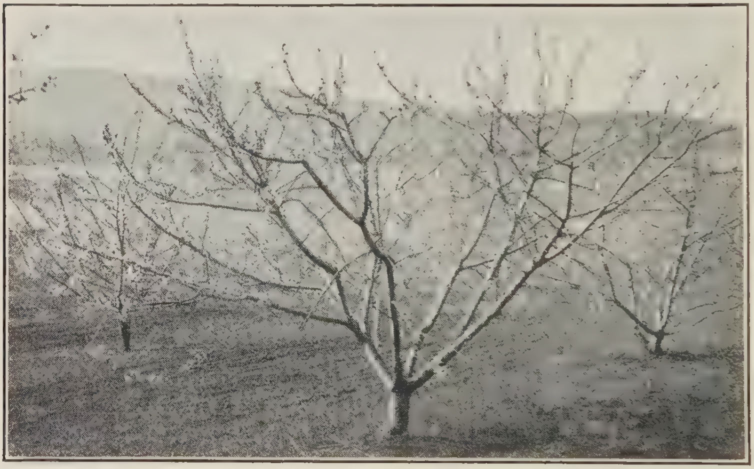


Fig. 91. An open center peach tree, six years old, well trained and pruned. Less thinning and heading back of last year's growth was necessary in this tree than is usually advisable. In some districts more branches may be left, i.e., where brown-rot is less prevalent than in Virginia, where this tree grew

Regular pruning. Winter pruning stimulates the production of new wood. Summer pruning may be used to retain the fruit buds as near the trunks as possible. If done too early it may start a second growth of weak wood which is undesirable. It is usually wise to prune regularly, taking off a certain amount of wood each year, and yet some very successful men have grown trees to a good size by little pruning, trusting to heavy crops to prevent the growth of much wood. Where short spurs are secured and each bears a fruit there seems to be little need to upset the tree's habits by pruning.

Time to prune. Many growers prune all winter. it is unwise to prune trees severely when the wood is frozen. It encourages die-back. If the trees are to be heavily pruned the best time is after the sap has started in the spring and before the leaves start, although some prefer to wait until growth has just started and the movement of the sap is well established. Such heavy pruning given in mid-winter when the wood is frozen and especially if followed by severe weather is apt to cause a number of branches to die. Usually the oldest trees should be pruned first and newly planted trees should be left until spring.

Pruning frozen trees. If a tree is frozen but not killed by cold it is wise to give it a chance before cutting it back severely. Either pursue a policy of waiting or give very little pruning. A frozen peach tree usually makes a better recovery than the apparent condition would lead one to expect. The dead wood can be removed after growth has started. At the same time, if one so desires, such buds as are not needed may be nipped off by hand.

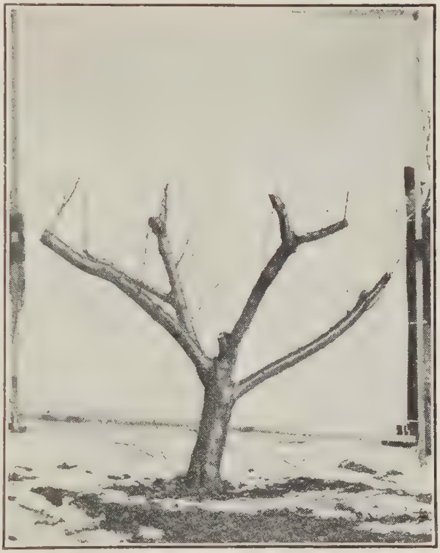


FIG. 92. "Dehorning" or better "deheading" the peach tree is sometimes practiced. It is usually wise to wait until the buds are starting to grow or to do it a year that the fruit crop is destroyed by frost. It may be done to throw the bearing wood nearer the trunk. Some prefer to cut back one limb a year after the fifth or sixth year of age. See FIG. 93

Pollination. The peach tree is usually considered self-fertile although some varieties are weak in this respect and with such it is desirable to mix varieties in the orchard to secure pollination. J. H. Hale lacks ability to pollenize itself and other varieties recorded as shy bearers may be likewise. Usually it does not seem necessary to have bees in the orchard to transfer the pollen. Elberta pollen will fertilize the Elberta blossoms and the seedlings secured from fruits so pollenized are apt to resemble the parent somewhat closely. Some varieties as Heath Cling can be propagated from seed and the offspring show but a relatively small variation from the parent. Elberta seedlings and Early Crawford seedlings are among many which show a large percentage somewhat like the parent.

Time of bloom and ripening. Taking 179 varieties reported by Hedrick in New York the indications are that the later the bloom, the later the period of ripening. This is shown in the table below:

RIPENING PERIOD

Blooming Period	Very early	Early	Medium	Late	Very late	Total
Very early . . .	0	0	1	0	0	1
Early	3	4	13	3	2	25
Medium	3	15	53	43	15	129
Late	1	1	6	7	5	20
Very late . . .	0	0	1	1	2	4
Totals . . .	7	20	74	54	24	179

Clean cultivation and cover crop. Some growers prefer to plow the orchards in the spring; others plow to the tree in the fall and in the spring away from it, while others will not allow a plow in the orchard, preferring the disk, the California orchard cultivator or other tool which will not go over 3 inches deep. The disk harrow run in two directions as soon as possible in spring will cut up the cover crop. From early spring until July or August, and if the season be very dry until the crop is ready to harvest in the Northern states, the orchard is kept thoroughly tilled, no weeds being allow to grow. Clean cultivation is practiced. If the season is normal a cover crop may be sown in July or August. When the orchard is bearing a crop of fruit the cover crop should be such as will not take the water away from the trees. For localities in which they thrive, cow-peas are usually a satisfactory cover crop; further north soybeans have a place. On sandy land in the Atlantic Coast states crimson clover does well; further north red clover suits better. Hairy vetch may be used, but it takes up much water and its seed is costly. Sweet clover is a favorite in places, and in some orchards is grown annually. In the southern belt other southern leguminous crops may suit. Among non-leguminous crops buckwheat is satisfactory. Rye is never satisfactory; a peach has no use for a rye plant. The rye seems to stunt the tree and it is a nuisance in spring. Barley and oats are sometimes used but Dwarf Essex rape or cowhorn turnips or a mixture of buckwheat and rape and turnip and clover is better. All weeds may be allowed to grow for they make a good cover crop. A rotation in cover crops is desirable—first year, red clover; second year, rape; third year, clover; fourth year, buckwheat, etc.

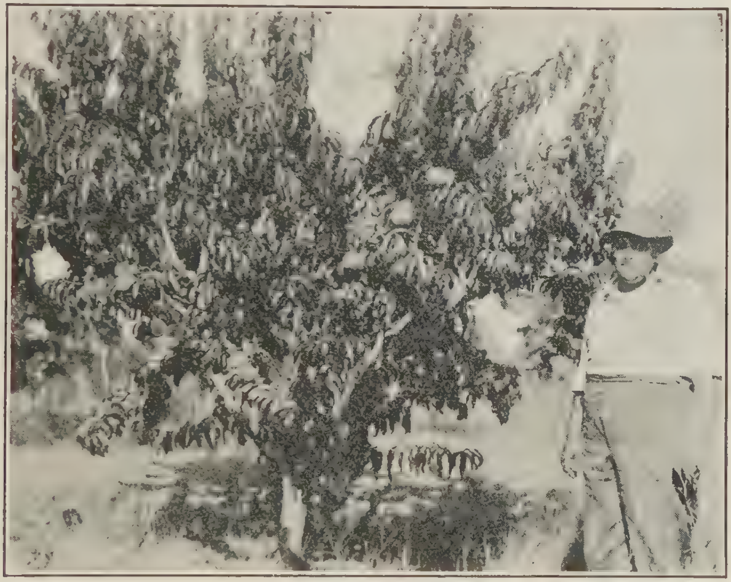


FIG. 93. The growth made in a season on the tree shown in FIG. 92. Vigorous trees may stand the treatment. A tree not in good growing condition will not do well if cut back hard

Labor. The usual estimate is one man by the year and a horse to each twenty acres of peach orchard. For the purpose of cultivating, where thorough work is done, this horse-power may prove a little low. The tractor has greatly increased the acreage a man can cultivate. Extra labor will be needed for thinning and harvesting. Estimating a tractor's life (of the Fordson type) at 3,000 hours of work, one is warranted in the purchase if he can get 1,000 hours of work from it in a year. In some places 500 hours of work may make it profitable.

Inter-cropping. For the first two years after planting and while the trees are young, inter-crops are sometimes raised. A low-growing crop is preferred. In the South it may be cotton or peanuts and in some cases corn. In Delaware it may be truck crops, potatoes, tomatoes, peppers, sweet corn or perhaps field corn, but owing to its shade, corn is the least desirable. In New York and Michigan it may be potatoes, beans, corn or even a crop of turnips sown broadcast in August. Squash, pumpkins, cucumbers and all kinds of truck crops are grown. In a few cases strawberries or a bush fruit is used, but it is not worth the while. Raspberries may have crown gall and pass it on to the peach trees. Grain crops, other than perhaps buckwheat, never have a place in a peach orchard, and the man who leaves a peach orchard in clover sod for a year must know how to handle it. It is done successfully by discerning men in some sections and will be a miserable failure in the hands of others.

Fertilizers. On the sandy soils of the Atlantic Coast fertilizers show their best results. A complete fertilizer is generally best for a long test. Nitrate of soda has frequently proven of marked influence, increasing the yields 40 to 50 per cent over plants receiving no nitrate; the tendency of heavy applications of nitrate of soda is to cause alternating heavy and light crops. Nitrate of potash when cheap enough has proven efficient in New England. Barn manure is used by many growers when obtainable. An annual growth of at least 12 inches on the tips of the leading branches should be maintained. Many orchards are grown without any fertilizer, but in others, half a ton per acre of a high grade fertilizer is annually used. Each grower must test the matter for himself.

Protecting peach trees from frost in New York. Hedrick summarizes peach-growing in New York as follows: That little can be done to protect trees from frost; orchard heating, whitewashing the trees, etc., are too uncertain and too costly; selection of a frost-free site is of prime importance; a warm, dry subsoil is required to ensure hardy trees; it is only on such that the tree gets into proper condition to winter safely. Soils which are too dry in winter cause the twigs to shrivel and freeze deeply and the trees in a wet, sappy condition are easily winter killed. Fertilizers which stimulate a vigorous growth in early summer are useful and those which cause a late weak growth in fall may be very detrimental. Underfed trees are apt to be winter-killed, as are those which are overfed. Cover crops have aided in saving orchards from winter injury. The lowheading of trees is advisable, since it protects the trunk from the sun, the wind has not the same force and cannot cause so much evaporation. Low-headed trees are usually more vigorous than high-headed, while windbreaks are generally of little value. Young trees are more easily injured by cold than older trees because they are usually less mature, but if recovery is possible they more readily recover. Old trees injured by borers and disease and low in vitality are less hardy than young trees. Trees which bore a heavy crop the year previous are more apt to be injured. A temperature of 20 degrees below zero under the best of conditions kills the peach. Trees may be killed at any temperature between zero and 20 degrees below. Fifteen degrees below zero under the best of conditions kills the fruit buds. Small-growing varieties with compact heads are hardier than free-growing varieties with large heads. The following varieties are more hardy than average: Chili, Crosby, Gold Drop, Barnard, Kalamazoo, Triumph, Wager, Fitzgerald;

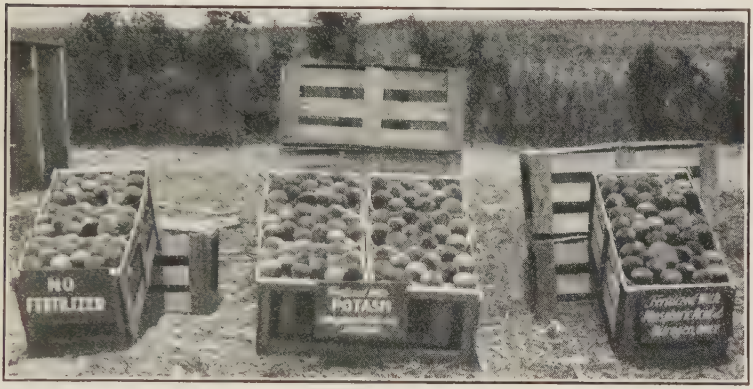


FIG. 94. A fertilizer test in Georgia, showing Georgia carriers. Three packed 3-2, one in center group 2-2, Variety Belle of Georgia. Packed by Berckman Bros., Mayfield, Ga. Showing fruit from three experimental plats. 1. No fertilizer packed 115.4 carriers per acre. 2. Potash, Phosphoric acid and nitrogen packed 446.6 carriers per acre. 3. Phosphoric acid and nitrogen packed 297.7 carriers per acre. The results merely emphasize the importance of running tests on one's own orchard to determine what to use

in New York, Crosby, Chili, Stevens, Gold Drop and Elberta are the most hardy in wood; Early Crawford, Late Crawford, Chairs, St. John, Niagara are the most tender in wood; Crosby, Chili, Triumph, Gold Drop, Stevens and Kalamazoo are the most hardy in bud and Early Crawford, Late Crawford, Chairs, Reeves and Elberta are the most tender in bud.

Protecting peach trees from frost in southern regions. Any course of action which causes the peach trees to grow vigorously and maintain their foliage late in the season, so that their leaves hang on until removed by an autumn frost, will tend to keep the buds dormant longer in spring. This is of importance where crops are lost due to the buds freezing after they have started to grow. This appears to be contrary to the view usually held about having well ripened wood, but there is a mean between having foliage dropping in September and having the wood so immature in December that it winter kills. The earlier that trees go into winter rest the earlier they wake up in spring. The aim is to keep the buds awake as long as possible in fall. This can be aided by (a) heavy pruning in late winter or early spring to stimulate plenty of wood growth: (b) good cultivation started early in spring and carried well into summer, and the use of a leguminous cover crop where the moisture content permits; and (c) on thin soils the trees should be kept vigorous by the aid of nitrogenous fertilizers.

Whitewashing. At the Missouri Station, the spraying of the trees in December or January with a home-made lime-sulphur wash, one with plenty of sludge in it, so that the spray formed a thin whitish coat over the tree, delayed the starting of the buds to such an extent that the sprayed trees produced two crops more in a decade than unsprayed trees alongside. These facts are of more importance to southern than to northern growers. Both must be careful that wood is sufficiently mature to withstand an early frost. In the southern peach sections there is little difficulty in getting trees to mature on time, but in the northern regions it is important that the maturity of the wood is sufficiently advanced as to avoid winter injury. This is true also of other fruits.

Color of the wood. Trees with a green bark do not absorb so many heat rays as do those with purple bark. The purple bark absorbs the heat rays on a warm day in February to the extent that the plant's temperature is 15 to 25 degrees higher than the air temperature. Such trees may start into growth on a day when it might normally be assumed no growth would be made. Buds which start to swell prematurely are more easily injured by cold than buds which are dormant; also they are more apt to open early and to be caught by frosts at bloom. The plant breeder now considers this factor of color of wood. Today we hunt for trees with green or yellow wood, not purple.

Orchard heating. A crop may be saved at the time of bloom by heating if the temperature does not fall too low, or the wind is not blowing too hard, and if one is ready with pots and material. Whether it is worth while is the question. In the East, the profits in peach-growing are so small that in most places it is deemed more profitable to take the loss from frost when it occurs than to spend additional money on equipment and go to the annual expense of getting everything ready. There may be conditions where these statements do not apply, but one needs to look the ground over carefully before undertaking much additional outlay in peach growing. In sections of the Mountain states and the Pacific Coast it is proven that orchard heating is possible. On a still night with seventy pots to the acre the temperature inside the orchard may be held four degrees higher than outside.

Peaches in California. Some California growers advise that when grown under irrigation, peach trees should be planted 24 feet apart, rather than less. That the trees be pruned vigorously when planted; even heavy trees should be cut back to 20 inches tall. That the growth made be cut back two-thirds and the limbs reduced to four the following spring; to shorten-in again heavily the following spring and in the fourth year to do less since the trees should bear a small crop. The after-pruning should consist of an annual reduction of the tree to maintain vigorous growth. Others give less pruning as outlined for Eastern conditions. The average life of the tree where irrigation is practiced is about fifteen years. Where irrigation is not necessary the life is twenty to thirty years or longer. Practically no orchard heating is practiced and it is only occasionally that a crop is seriously reduced by frost. The conditions in California are perhaps more uniformly favorable than in any other peach-growing region.

Thinning. When the trees set a full crop of fruit they should be thinned for the best development of the crop and the future of the tree. Thinning is usually done after the summer drop, or six to eight weeks after bloom, and just as the pits are beginning to harden. Some growers thin to a considerable extent by pruning the tree, thus reducing the amount of hand work later. The amount to remove is a matter of judgment; with vigorous trees and in a favorable season the tree will carry more than trees of lower vitality in an adverse season. Usually thinning from 4 to 6 inches apart if the whole tree is loaded and growth is vigorous is a satisfactory distance. The reason this operation is not practiced more is usually because of scarcity of labor and the cost.

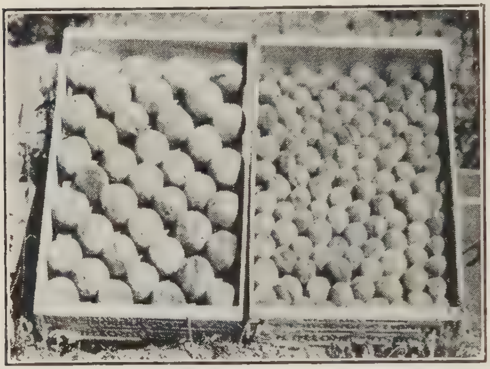


FIG. 95. The results from thinning peaches. Showing the size of the fruit from the thinned trees and those not thinned, also the box used for shipping Western peaches
Utah Agr. Exp. Sta.

Insects. San José scale is controlled by spraying the trees while dormant, with soluble oils, scalecide or lime sulphur. Fall spraying has come in during recent years and a word of caution is worth repeating and that is not to spray too early. This is especially true in the South; the leaves may be off and yet the trees not be dormant enough. Two or three sharp frosts should occur before spraying is done, otherwise the buds may be injured.

The peach-tree borer (*Sanninoidea exitiosa*) is known over the eastern United States and is a common cause of the short life of peach trees. The larva or grub hatches from an egg laid on the wood and it penetrates the bark, making tunnels just beneath it, sometimes girdling the tree. A mass of jelly and sawdust reveals its presence. The remedy is to go over the trees each fall and spring. Take the earth away from the base of the trunks and wherever there are signs of the presence of borers, find the channel and follow it until the insect is found and killed. Sometimes a piece of wire can be run up the hole to kill it. Leave the tree a day or two, then re-inspect and replace the soil if there is no further evidence of the insect. Painting the trunk of the tree with a heavy coat of lime sulphur sludge is suggested. Another remedy is the use of paradichlorobenzine. This is a powder, which is placed in a circle on the levelled soil at the base of the tree and about 2 inches from the trunk. The gum is removed. The soil is then mounded over the powder and compacted; the fumes generated kill the borers. It is usually applied in the fall—in the latitude of New Jersey, about September 1. On three-year-old trees, one-half ounce is allowed to stay about seven days, on older trees three-quarters of an ounce is allowed to stay about three weeks. It is then removed. In California it can be used on young trees with safety even in the nursery and is proving valuable for controlling borers and woolly aphis on apple trees. On the Pacific Coast the Pacific Peach-Tree Borer (*S. opalescens*) is combatted as outlined.

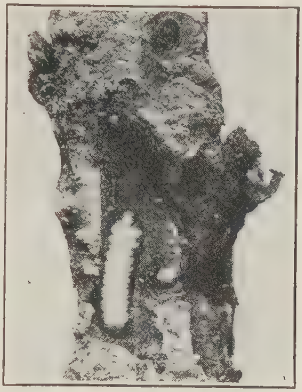


Fig. 96. The Peach-tree Borer. Removing the gum, sawdust and bark we find the borer. This is the larva or grub which does the damage. If left alone it may girdle the tree and in any event it will seriously weaken it. Fumigation with paradichlorobenzine is now practiced to destroy the borers

U. S. D. A.

The Lesser-Peach Borer (*Sesia pictipes*) is smaller than the other and works in the trunk and limbs of the trees and necessitates examination and worming of these parts.

The Lecanium or Terrapin scale (*Lecanium nigrofasciatum*) is more common in the South than in the North. The eggs hatch in June. While small, spraying the tree with fish oil soap, one pound to 4 or 5 gallons of water is suggested. If not controlled the fruit may show a sooty mouldy fungus which grows on the secretions of the insects. Spraying as for San José scale is advised both for this and the West Indian peach scale (*Aulacaspis pentagona*).

Plum curculio (*Conotrachelus nenuphar*). This insect is often a serious menace, because its punctures pave the way for the entrance of brown-rot spores. The mature female snout-beetle lays her eggs in a crescent-shaped puncture on the fruit.

The eggs hatch in a few days. The larvæ bore into the fruit and the fruit usually falls. The progeny pupate in the soil and emerge in time to live on the ripe fruit. Good cultivation, clean tillage, spraying with tri-plumbic arsenate of lead, 1 pound of paste to 50 gallons of water or 1½ pounds with 2 or 3 pounds of quicklime may be used as soon as the trees are out of bloom and while the shuck is still attached to the young fruit; repeat once again in two weeks or dust with arsenate of lead, lime and sulphur, 10:50:40.

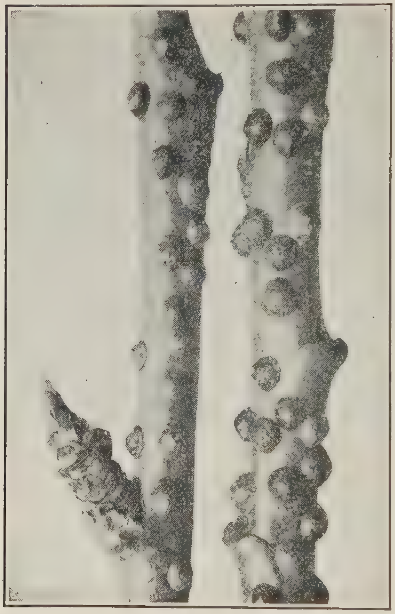


FIG. 97. Lecanium or Terrapin scale
U. S. D. A.

The Fruit-Tree Bark-Beetle (*Scolytus rugulosus*) **and the Peach Bark-Beetle** (*Phlœostribus liminaris*) are two insects which bore holes like those of small shot in the wood of the tree. Usually the effect is seen where the trees are partially neglected or where old stumps and branches are left around for them to breed in. Give the orchard better care, clean up and coat the affected wood with lime sulphur, full strength.

The common rose chafer sometimes destroys a crop of fruit. Give cultivation, sanitation and find the breeding-place. Usually it is in sandy soil nearby. Destroy by tillage.

Peach aphis are of two kinds. The black aphis (*Aphis persicæ-niger*) is common on light soils and lives underground. It often causes the tree to show yellowish foliage, and has led some growers to destroy their trees, believing them to be affected by yellows. Give good tillage and encourage growth, place tobacco stems round the trunk of the tree or work a pound or two of waste tobacco into the soil, surrounding the base of the tree. The green aphis (*Myzus persicæ*) lives above ground on the foliage. Spray or dust with nicotine.

Oriental peach moth (*Laspeyresia molesta*) has recently assumed importance, having reached this country through Japan, in shipments of flowering cherries or peaches. It does considerable damage to peaches and pears and will attack cherries. Since it is a near relative of the codling moth and has a wide range of plants on which it can live its presence has created alarm. It is found in the eastern part of the United States in relatively limited areas. It causes injury to the twigs and to the fruit, usually while the twigs are young. The first brood lives on the young wood. In the second brood the larvæ work on the fruit, although they may begin to work on the twigs and pass to the fruit, boring into the sides of the peaches. In the third brood they work on the twigs and will attack the fruit. A fourth brood may attack late-ripening peaches. In some sections there is a fifth brood which works on the quince and apple. No control thus far is available, but fortunately a number of parasites tend to keep the insects in check.

The Mediterranean Fruit-fly (*Ceratitis capitata*) does considerable damage to the stone fruits, such as apricots, plums and nectarines; also to apples and pears. It is found living also on some of the tropical fruits. At present, a rigid quarantine exists against it. The adult resembles a house-fly somewhat. The female pierces the skin of the fruit with the ovipositor, and deposits one to several eggs beneath the skin of the fruit. The eggs hatch in from two to four days, and the larvæ feed on the inside of the fruit. The adults seldom puncture green fruit, preferring fruit which is nearly ripe. The larvæ live from two to three weeks, usually in the fruit, then fall to the ground, where they pupate. In from two to three weeks, the adult flies emerge, to repeat the operation. The females may live several weeks. It is impossible to poison the larvæ which are inside the fruit. Destruction of the injured fruit may help somewhat, but the most reliance is now placed upon the application of sweetened arsenical solutions applied to the trees, for the young flies have a fondness for the sweets, and will feed on these if placed on the foliage. The solution used may consist of arsenate of lead paste, 1 pound; crude treacle 2 gallons and 20 gallons of water. Twenty pounds of cheap sugar may be substituted for the crude treacle. The treacle sticks somewhat better than the sugar. The idea is to spray the foliage so that the spray stays on it in small drops. Only part of the foliage should be sprayed, so that it is usually applied with a garden syringe. A spray pump puts on too much. The spray material should be stirred for each tree.

The Yellows. Although recognized for 125 years it is not known whether or not peach yellows is a disease or a condition. It exists north of the Potomac River and east of the Mississippi and at times has swept the peach industry out of existence in one locality after another. No cure is known. The mode of management is to cut out and dig up affected trees as soon as seen, and burn them.

Rosette. Rosette seems to run a similar course to yellows. It is recognized by the tufts of leaves or rosettes which grow along the branches. It is not found north of the Potomac. Treatment is as for yellows.

Little peach has been recognized in the northern peach-growing states as a serious malady. The fruit stays small, hard and worthless. The trees fail and slowly die. Dig out and burn the trees as soon as seen.

Big peach is seen in New Jersey. The fruits grow to two or three times normal size. Cutting out and burning the affected tree is so far the general mode of handling.

Brown rot (*Sclerotinia cinerea*) attacks the foliage, flowers, fruits, buds and wood of the tree. It is a fungus disease. In a wet season it is often seen on the fruit after it is shipped as small brown patches which rapidly increase. Fruits left on the trees hang all winter as ''mummies.'' The disease may be carried over by them, or on the twigs or in cankers which appear on the older wood. It may cause the young shoots to wilt and turn brown. The spraying of the tree while dormant with lime sulphur is beneficial. Summer sprayings with wettable sulphur or self-boiled lime sulphur 8:8:50, or dry mix, two to four times during the season at intervals of two weeks, beginning when the fruit is set will keep it in control. In some cases a spraying given as the blossom buds show pink is the important spray of the season—previous to the sprayings mentioned. It is not advised to spray within a month of harvesting the fruit, but it is quite feasible to dust. Dusting with sulphur is rapidly becoming an established practice, using 80 pounds sulphur, 10 of lime and 10 of arsenate of lead when curculios are present. The disease cannot penetrate the skin of the peach. It enters at punctures made by curculios or wherever the skin is broken.

Scab (*Cladosporium carpophilum*) is a destructive fungus disease which is seen on the fruits as small black spots which stunt the fruit, rendering it tasteless. It also attacks the twigs. To control spray or dust as for brown rot.

Powdery mildew (*Sphærotheca pannosa*) is controlled by the self-boiled lime sulphur spraying or dusting with sulphur.

Crowngall may injure the roots in some places, although the problem is one needing further investigation. Affected young trees should not be planted. The raspberry suffers from the same disease, and should not be planted with the peach.

Peach Leaf-curl (*Exoascus deformans*). In the northern parts of the United States this is one of the most serious troubles of the peach. The spores of curl fungus pass the winter among the hairs on the bud scales. Weather favorable to the growth of the bud germinates the spores. Every bud on the tree is liable to be infected. The remedy is to destroy the spores which develop the curl. This is done by spraying with copper sulphate, 2 pounds to 50 gallons of water; or bordeaux mixture 3:3:50; or lime sulphur, 1 gallon to 15 gallons of water. If San José scale is present lime sulphur is used, 1 gallon to 8 gallons of water. One of these sprays should be used in fall after the leaves have fallen and the trees are dormant, but not in freezing weather. Formerly this work was done only in spring. The weather is usually much better and the hauling of the sprayer through the orchard is much easier in early winter than in spring. Serious injury to the tree has followed fall spraying in some places, especially when it has been done before the trees are fully dormant. It must not be done too early. Dusting with Sanders dust or other copper sulphate-lime dusts will control.

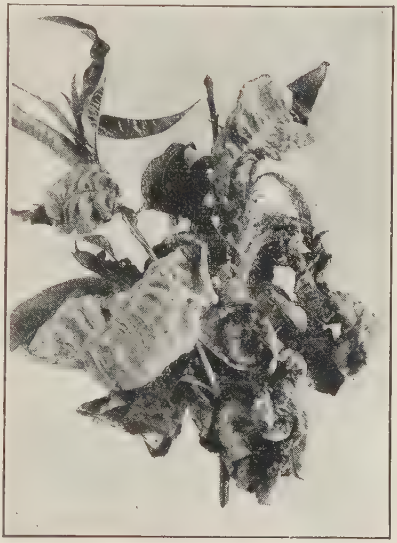


FIG. 98. The Peach Leaf-curl disease

Spraying program. The spraying campaign should consist of:

1. A late fall or winter spraying (when not too cold) with lime sulphur or some oil spray to destroy San José scale and control leaf-curl and brown rot. If not done in the fall it can be done in the spring if applied early enough before any buds start.

2. When the shucks are falling from the peach, to control curculio and brown rot spray with self-boiled lime sulphur, atomic sulphur or some other prepared sulphur paste and arsenate of lead adding 2 or 3 pounds quicklime per 50 gallons to the mixture if arsenate of lead is applied in combination or alone; or dust with 90 parts sulphur and 10 parts of powder arsenate of lead.

3. Repeat Number 2 in fourteen to twenty days and once more in two or three weeks if needed, omitting the arsenate of lead if it is not needed. In certain regions special applications may be profitable, as spraying with self-boiled lime sulphur or dusting with sulphur as the buds show pink. Average trees of mature size will usually require 1½ gallons of spraying material per tree when dormant and about 2 gallons when in leaf.

Dusting program. In dusting one may need to make twice as many applications as when spraying, some growers making eight to ten in a season with excellent results; some substitute 50 per cent of hydrated lime for that amount of sulphur in some of the dustings and do not apply arsenate of lead unless necessary.

Harvesting. All fruit is best for eating out of hand when ripe. Harvesting must be so timed that the fruit will not be fully ripe before reaching the consumer. The peaches may be picked from two to seven days before fully ripe, depending upon the distance to market. Ripe fruit may be sent to the local market. The fruit is said to "plump up" some twenty-four hours before it should be picked; thus even for long distance shipment the white-fleshed peaches should not be picked while green in color. The skin should be allowed to get some blush or color on one side and be whitish or at the least a greenish white on the other side. If it is a good shipping variety like Belle, it should be white but still firm and not quite at its best for eating. Fruit picked and put into cold storage to cool will not ripen as fast as if left on the tree. Yellow-fleshed varieties are usually gathered when the fruit has colored on one side and is a yellowish green to orange yellow on the under side and while still firm. The picker must learn to judge the fruit by the eye. The novice may pinch fruit to see if soft, but wherever a ripe peach is so handled it is injured. It is a matter of fine adjustment to get a crop of peaches harvested at the right time. The grower will acquire judgment after a few seasons' experience and will appreciate the influence of weather and wind and storm in deciding when to harvest.

How to pick a peach. The fruit is taken in the palm of the hand and without pinching it is tipped sidewise with a little twist to release it from the stem without tearing the flesh or giving a bruise by direct pulling. A good picker will harvest 30 to 50 bushels of a standard variety like Elberta in a day. Where there is considerable variation in the ripening of the fruit or the fruit is small less is done.

Handling the crop. For local markets and canning the fruit may be handled direct from the orchard to market. When the crop is to be shipped it is usually hauled to the packing-shed to be graded and packed. Many growers keep the trees low headed so that the fruit can be picked from the ground, others use a short step-ladder.

Packing the carrier. In a modern plant the system of grading depends upon the package used. When shipped in a Georgia carrier the fruit may be packed direct from the picking baskets or be sized for the packers. The fruit placed in the bottom layer of the till is not quite as large as that on the top layer. The value of size will be apparent when packing, for with fruit 8 inches in circumference a packer might put up 200 crates a day, while with fruit 7 inches in circumference he could do but 150 crates.

Packing the bushel basket. For shipment in bushel baskets, the fruit is first run over a mechanical sizer which usually makes three or four sizes. The fruit is poured in a regular stream onto a canvas conveyor. Two or three persons stand at each side of the conveyor and remove the ripe and defective peaches, which are carried away on another belt. Those left are rapidly sized, and fall into baskets placed in proper position to receive them. The cushion and cover are placed on the basket, which is stencilled and placed at once in cold storage to cool before loading in the car. If there is a car pre-cooling outfit it might go directly into the car, but by turning the cold storage into a packing-plant and cooling the fruit off and at the same time cooling off the car for ten to twelve hours before loading, good deliveries can be made. If fruit is to be pre-cooled or held in storage it is best to leave the pad or cushion off the basket until ready to load for shipment, although baskets so handled cannot be piled up without some damage to the fruit. Elberta peaches are sometimes held in storage for a month or six weeks. They lose much of their flavor in a month and unless very carefully handled decay may set in.

New York grades. New York has an optional grading law for peaches. The points considered essential in a peach pack are that the fruit shall be of good to large size for the variety, high in color, uniform in both size and color, free from bruises, insect and fungus injuries and that it shall have the full and characteristic flavor of the variety. AA is extra fancy; A is fancy; B is smaller; C is ordinary run and poor stock.

The grades and the price of a crop of peaches. The Oak Harbor Fruit Company of Ottawa County, Ohio, in one year handled 108,762 bushels of peaches for the account of 130 growers. There were 11,550 bushels or 11 per cent which graded ''AA'' and netted the grower $1.30 per bushel; 43,997 bushels, or 40.5 per cent graded ''A'' and netted the grower $1.01 per bushel; 48,034 bushels or 44.2 per cent graded ''B'' and netted the grower $0.55 per bushel; 2,853 bushels or 2.7 per cent graded ''C'' and netted the grower $0.30 per bushel and 2,323 bushels were of no grade. Taking 100 bushels, the 11 per cent of ''AA'' made $14.30 or 17.6 per cent of the revenue; the 40.5 per cent of ''A'' made $41.91 or 51.7 per cent of the revenue; the 44 per cent of ''B'' made $44.75 or 30.7 per cent of the revenue and the 3 per cent of ''C'' made 90 cents or 1 per cent of the revenue. The 50 per cent grading ''A'' or better produced two-thirds of the money and this was the only portion of the crop which made a profit. Even in a year of good prices the lower grading half furnished no net revenue. Part of it met its costs.

Packages. The Georgia carrier is the best package in the East for long distance shipment of fancy fruit. A useful package for nearby markets and especially for early peaches is the Climax basket. It is made in standard sizes as 4, 6, 8 quarts, etc. The fruit is packed in layers. In New York, 10, 14 and 16-quart splint peach baskets are in use. These have wooden covers or may be covered with red tarlatan for local use. Some of these packages are used in New England. The Jersey 16-

quart and five-eighths bushel hamper are the standard home-trade packages of the Atlantic Coast states. The round bushel basket and a half-bushel basket of the same shape are also used. The bushel basket is rapidly increasing in favor for moving the mass of fruit for canning factory and for general market purposes. It is a good commercial package if properly made. It is easy to pack, handle, load and ship. It is extensively used in the Central states in Ohio, Michigan and New York and is increasing in popularity in the markets. The round flat-bottomed bushel tub is more rigid than the basket. Fruit shipped from California, Oregon and Colorado is packed in a special box 5x11½x18½ inches inside; the ends are of three-quarter-inch wood and the bottom and sides of three-eighth-inch pine. The fruit is wrapped and the package used for fancy fruit only. An attractive label pasted on the package is common.

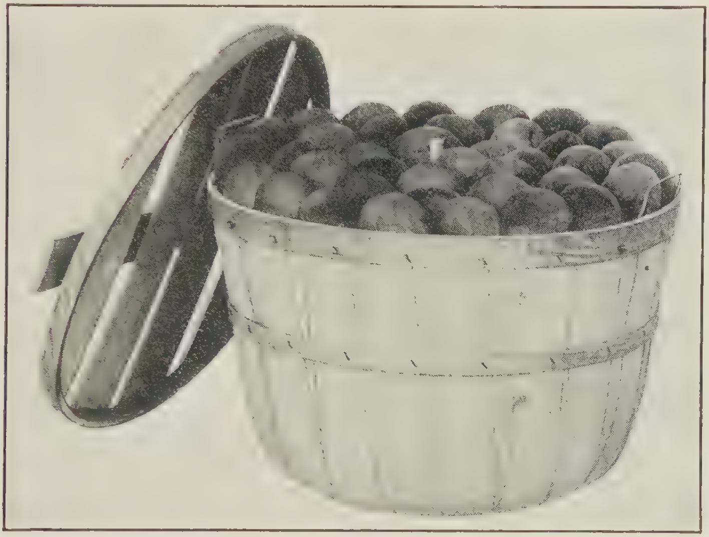


FIG. 99. Peaches in the Universal Bushel Basket, showing Hoop Cover and Center Post. A corrugated cap is usually used under the cover. This package is used for apples, pears, plums, quinces and other fruits

Loading Georgia carriers. A floor rack is needed in every refrigerator car. The packages are loaded side by side, seven carriers wide. Two-inch strips, the width of the car, are placed on top of the carriers at each end and nailed into place. The car is loaded five to six tiers, according to the condition of the fruit and the car. A brace is put in the doorway to hold the carriers firm.

Loading bushel baskets. One excellent method is to place the first row along the side of the car from bunker to bunker, care being taken to leave a space of a few inches between the end basket and the bunker at one end. The next tier is started by placing the first basket wedged against the walls of the car so that half the basket is over the empty space and half on the basket. All baskets in that tier rest on two baskets. They are not tiered on top of each other. The third tier is placed over the first and the fourth over the second. The next row of baskets on the floor of the car is offset, so that they rest in the space between two baskets. Loaded in this way no basket rests directly on another. It rests on two, and there is no direct weight on the contents. It is all on the basket.

Canning peaches. Commercially, California is so far in the lead in the production of peaches for canning that it practically enjoys a monopoly. About 60 per cent of the crop may be canned. The growing of clingstone varieties for this purpose is extensively practiced. While some home canning is practiced elsewhere and a small amount of the eastern crop is canned for commercial purposes, there is no commercial production of strictly canning peaches in the East, although there is increasing interest in the subject. The qualities desirable in a canning peach are distinct from those of a table peach. The requisites of a canning peach are: (1) Attractive appearance when canned; (2) a clean-cut outline—for example, freestone peaches have ragged, discolored centers and are not firm enough to retain a clean-cut outline, they cloud and discolor the syrup and present a ragged appearance; (3) the flesh must be fine-grained, sprightly and highly flavored, have a small pit cavity and same must be free from red, for this discolors the syrup; (4) the size must be large enough to give eight halves to a 2½ can. Fruit packed eight to ten halves to a can is Fancy; ten to twelve grades Choice; ten to sixteen is Standard. The skin is removed by dipping in lye, which causes it to come off quickly in the hands, the pit is removed by means of a peach-pitting spoon, which leaves a smooth, clean-cut center. While the Crawfords are sometimes canned whole, the leading varieties are Tuskena or Tuscan Cling, Runyon, Seller, Levy, Orange, McKevitt, McDevitt and Phillips.

Drying. Practically no part of the eastern crop is dried. A large part of the California crop is so used. Drying has not proven profitable in the East. California can dry in the sun. Among the varieties preferred are Muir and Lovell, both of which are rather dry, fine grained, firm fleshed, yellow freestone peaches, and they ripen in succession. A normal output is 30,000 tons of dried peaches. To peel the fruit it is dipped in hot lye, 1 pound to 10 gallons of water for 50 seconds, then into cold water; so treated, the skin is easily taken off. The fruit is dried on trays in the sun. Permanent drying yards are equipped with tramways for hauling the fruit easily.

The fruit is first sized and graded, then split, and the pit removed. The fruit may be peeled or not and is laid in shallow flat trays, cups up. When split the fruit is bleached by passing it over the fumes of sulphur. The sulphur fumes prevent the fruit from spoiling and turning dark colored while drying and cause it to dry in about half the time it otherwise would. The trays are spread in the sun to dry. If it rains they are protected. When dry, the fruit is graded and cleaned and then stored in a mass to sweat. This makes the fruit uniform in moisture content. Before packing it is sometimes sterilized by dipping in boiling water. After drying for twenty-four hours under cover it is packed in boxes. A common size of box is 6x9x15 inches inside measurements, holding 25 pounds of fruit. A variety like Muir will furnish 1 pound of dry fruit from 4 or 5 pounds of fresh. More juicy fruits require 6 or 7 pounds. Apricots and nectarines are also dried like peaches.

Selling peaches. The northern peach crop is moved in September. In some cases the same markets are supplied with peaches from Michigan, Ohio and New York. In addition, during recent years, owing to favorable freight rates, peaches from Colorado, Washington, Oregon and California may reach the same markets. This merely illustrates the competition.

Necessity for grades and standards. A perishable crop like peaches must move at once, and must either be packed to a standard grade or sold subject to inspection on arrival. Standardizing the grade and pack is desirable.

Costs of production. Uniformity in yield is an important factor in determining costs of production. To illustrate this fact and at the same time give an idea of the costs in various regions data are presented from such points as New York, West Virginia, Georgia and California. In New York, Professor Hedrick gave the following as representative costs in the pre-war period, under favorable conditions:

VALUE OF ORCHARD, $400 PER ACRE

Interest on investment	$20.00
Taxes	1.00
Depreciation in equipment and interest	20.00
Tillage	10.00
Cover crop seed	2.50
Fertilizer	5.00
Pruning and thinning	6.00
Keeping pests under control	8.00
Superintendence	30.00
Picking, grading, packing, hauling	30.00
	$132.50

With 100 trees per acre, the cost of handling a bearing tree for a year is $1.325. A fair average yield is 150 bushels per acre which gives an average production cost of 88 1-3 cents per bushel, not including the package for the year of bearing. The expectation of yield is that the trees will be in bearing when five years old, and have a bearing period of ten years in which three crops will be lost which gives an average of seven crops in a fifteen-year life. It follows that if $400 is the value of the orchard and $200 is the value of the land that $200 per acre must be amortized by the seven crops, which is a charge of $30 per acre or another 20 cents per bushel. The costs during the three years the trees were not in bearing remain the same except for harvesting, so that the actual average cost of each bushel sold was about $1.48. In West Virginia the average cost during the life on 144,000 trees was $1.26 per bushel. The usual life of the tree is thirteen or fifteen years and six to ten crops are expected. The usual life-work of a tree is ten to thirteen baskets of one-half bushel each. The actual average in one orchard was 14 half-bushel baskets in fourteen years and in another 17 baskets in eighteen years. In another case where an average of 16 baskets was secured in a sixteen-years life, the average sale price for the eight crop years was 74 cents per basket. The surplus above operating expenses available for payment of labor income and profit was 11.44 cents per basket or $1.83 for the life work of a tree. With an average of 135 trees per acre this is $15.45 an acre a year for sixteen years.

Georgia peaches. In Georgia the crop is grown for shipment. Shippers report from 75 to 95 per cent of the movement between the years 1913 to 1921 inclusive, as marketed east of the Mississippi River and north of the Ohio River. About 2 per cent of the crop was sold in the state and moved by express. In 1921 about 1½ per cent of the crop was exported. The packages used are the Georgia carrier shipped as 42 pounds when packed, and the bushel basket shipped as 50 pounds. A common load was 476 carriers shipped as 20,000 pounds. From 386 bushels to over 400 bushels is a common load. That the peach growers' problem in Georgia is not an easy one may be seen by the record of the crop and its cost in the case of one grower. The costs given are the costs per season, without interest, taxes, depreciation or salary for the operator.

YIELDS AND COST OF PRODUCTION OF PEACHES IN GEORGIA 1913-21

			Cost per crate
1913		14 Cars	$1.50
1914		30 "	1.35
1915	no crop		——
1916		7 Cars	2.50
1917	no crop		——
1918		138 Cars	1.60
1919		2 "	——
1920		49 "	5.25
1921		243 "	Not complete Estimated about .90

Another record shows:

		Cost per crate*
1917	33 Cars	.80
1918	93 "	.70
1919	107 "	.81
1920	34 "	1.66
1921	130 "	.88

* Does not include interest, taxes, insurance, office expense, depreciation on orchard, live stock and equipment, salary for manager, nor amortization, and the orchard being on leased land the cost of bringing the trees into bearing must be charged off.

Data based on records of a number of large growers averaged shows the following costs per package—crate or bushel—for the first-grade fruits as follows:

COST OF PRODUCING A GEORGIA CARRIER OR BUSHEL BASKET OF PEACHES 1913-21

1913	$ .75
1914	.85
1915	1.00
1916	1.25
1917	1.25
1918	1.50
1919	1.60
1920	1.60
1921	1.20

The record of 2,100 cars, or 951,702 packages, sold on consignment in 1921, showed gross sales of $1,842,368; transportation charges, $791,812 or 43 per cent, and miscellaneous handling costs and commissions, $155,000, or 8.4 per cent. The grower received f.o.b. loading point, $895,556, or 48.6 per cent.

The comparative figures per package for 1920 and 1921 were:

	Per package 1920	 1921
Gross Sales	$1.895	$1.936
Transportation and all selling costs	.934	.995
Net to producer	.961	.941

The average haul for the Georgia peach crop is 1,000 miles. For this service the railroad received almost 43 per cent of the proceeds in 1921. In 1921 approximately 2,500 cars of Georgia peaches were sold for approximately $1,200,000, which sum was absorbed entirely in the payment of freight, packages, packing so that nothing was available for payment of production costs.

The costs in California are relatively stable, the crop yields being uniform. The fruit is packed in boxes holding 21½ pounds. Data for the same period as above from several growers' organizations are shown in the following table:

AVERAGE COSTS OF PRODUCING CALIFORNIA PEACHES PER BOX

	Size of crop	One group Cost per box	Another group Cost per box
1913	95 Cars	.42	.439
1914	72 Cars	.42	.439
1915	80 Cars	.42	.439
1916	70 Cars	.42	.439
1917	83 Cars	.55	.526
1918	66 Cars	.703	.526
1919	80 Cars	.773	.526
1920	78 Cars	.773	.773
1921	110 Cars	.703	.703

The above costs do not include interest, insurance, upkeep and taxes, being merely the operating cost, packages, packing and loading. From 20 to 60 per cent of the crops of these organizations was sold east of the Mississippi River. The boxes were usually loaded 1,211 to the car.

Two crates of peaches. During 1920, when Baltimore was well supplied with Maryland peaches, S. B. Shaw took pains to follow some of the fruit through to the consumer. The story of two crates illustrates why the price of good fruit, properly graded and packed is greater than that of poorly grown, graded and packed fruit. Both lots of fruit were shipped in carriers, which held 24 quarts of fruit. The carrier containing well-grown, properly packed fruit sold at wholesale for $3.50. It was taken to the Lexington market, where the 24 quarts of fruit were repacked into eighteen small quart baskets, which were sold, heaped up, at 25 cents each, or for a total of $4.50. The retailer's gross margin was 22 per cent. Another crate of another pack of the same variety sold on the same wholesale market for $2. This was sold at retail in the same retail market the same day. The drayage on both crates was the same. The retailer was able to pack twelve small quart baskets out of the carrier and it took longer than to pack the eighteen out of the other crate. These were sold at 25 cents each or $3. The retailer found a very slow sale for the balance of the fruit from these crates at 10 cents for the entire bulk. The only way to move these peaches was to repack. The retailer's margin was 33 per cent, but the actual money he received for his time and labor was no more than the other retailer received for handling his crate. The poorly graded fruit was also more work to sell. The one who lost out on the transaction was the grower. There was no sale for the over-ripe fruit, which had to be culled out and sold at a loss.

Classification. Commercial peaches are classified according to: Whether the pit is free, or clings to the flesh as freestone, semi-cling and clingstone; the color of the flesh as yellow, white or red; the time of maturity, as early, mid-season and late; the skin, whether smooth or downy; the shape of the fruit, as round, flat or beaked; the size of the flower, large as in Greensboro, medium as in Belle, small as in Elberta, Early Crawford.

Nectarine. The nectarine is a hairless peach. In other characters it resembles a peach, but the fruit is smaller, has firmer flesh of a more distinct and finer flavor. Peach pits may give rise to nectarines and nectarine pits to peaches. A branch of a peach tree may bear nectarines and vice versa, in which case we have bud variation. Peach and nectarine trees may bear fruits which are half peach and half nectarine.

Nectarines are more generally grown on the Pacific Coast than in the Eastern States. The trees are not so hardy and are more subject to disease and insect attacks than the peach. Whether eaten fresh, canned or dried the nectarine is a desirable fruit for home use. California is the seat of the industry. Some new varieties have been introduced which can be grown in Texas and northward, as Tough, Wilkinson, Yellow, Breck, Griffith, and there is considerable opportunity for development. New White, Lord Napier, Newton and Hardwicke are important varieties in California, while for forcing and home use in the East, Boston, Elruge, Lord Napier, Pitmaston Orange, Rivers Orange, Pineapple and Victoria are popular.

CHAPTER XXXVII

THE PLUM

Of all the fruits in cultivation the plum (*Prunus spp.*) shows the greatest diversity in flavor, aroma, texture, color, form, size and character of wood growth. Plums grow all over the north temperate region, in all parts of the world, and are cultivated in all portions of the south temperate region. The plants in cultivation are drawn from several species. It is essential that these factors be considered by all who undertake to grow plums commercially. It must also be recognized that different varieties require different treatment; therefore, the plum grower must make a special study of the variety he intends to cultivate.

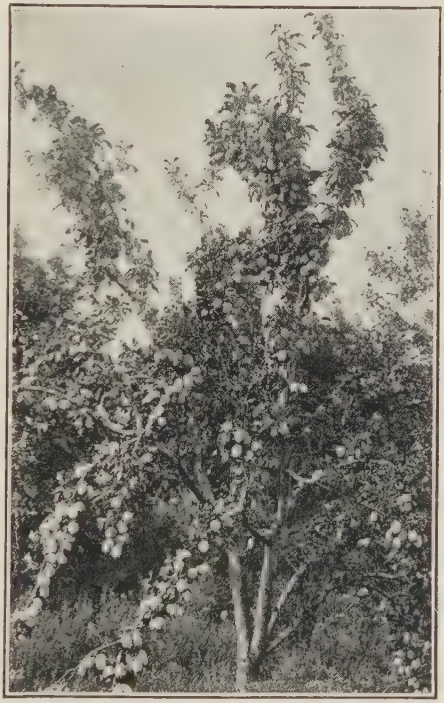


FIG. 100. Fellenberg Prune Tree at Nampa, Idaho, showing good distribution of bearing wood

Types of plums. For commercial purposes plums may be divided as follows: (1) Those of the old world which are usually spoken of as "Domestica plums." (2) Those introduced from China and Japan, which are usually spoken of as "Japanese." (3) The "natives" or those native in the United States and Canada. Hedrick, in "The Plums of New York," lists about 1,500 varieties of "Old World" plums. When recognized there will probably be just as many varieties of "native" plums. There is a wonderful list of Japanese and Chinese plums.

Geographical distribution. At the close of the nineteenth century there was a rapid increase in the number of plum trees in the United States. At the present time, the country may be grouped into three zones:

1. Western area. The states of California, Oregon, Washington and parts of Idaho and British Columbia constitute by far the most important area. The greater portion of their crop consists of prunes.

2. Great Lakes area. This area consists of Western New York, parts of Ohio and Michigan and the area grouped around the lakes in which is found the production of the Domestica plums which are used fresh.

3. Mississippi area. In this area are the states of the Mississippi Valley—Iowa, Arkansas, Kansas and part of Texas, where the native and the Triflora varieties are produced almost exclusively.

Climate. As with other crops, it is the climate of the locality which is of fundamental importance. Hedrick tabulated the more important varieties according to whether they would endure the degree of cold usually found in certain locations. This is shown below:

Showing the Hardiness of Certain Plums in Localities Named

H —-hardy HH — half hardy T — Tender

	Ohio	Indiana	Illinois	Kansas	Colorado	Nebraska	Western New York	Vermont	Ontario	Maine	Wisconsin	Iowa	Minnesota
American Plums:													
De Soto	h	h	h	h	h	h	h	h	h	h	h	h	h
Hawkeye	h	h	h	h	h	h	h	h	h	h	h	h	h
Wolf	h	h	h	h	h	h	h	h	h	h	h	h	h
Domestica Plums:													
Lombard	h	h	h	h	h	h	h	h	h	h	h	h	hh
Reine Claude	h	h	h	h	h	h	h	h	hh	h	hh	h	t
Bradshaw	h	h	t	hh	h	h	h	hh	hh	hh	hh	hh	t
Arctic	h	h	h	h	h	h	h	h	h	h	h	h	hh
Hortulana Plums:													
Moreman	h	h	h	h	h	h	h	h	h	?	h	hh	t
Golden Beauty	?	h	h	h	h	?	h	h?	?	?	hh	h	t
Wayland	h	h	h	h	h	?	h	h	?	?	hh	hh	t
Insititia Plums:													
Damsons	h	h	h	h	h	h	h	h	h	h	h	h	hh
Munsoniana Plums:													
Pottawattamie	h	h	h	h	h	h	h	h	hh	t	h	h	h
Newman	h	h	h	h	?	?	h	?	t	t	hh	t	t
Robinson	h	h	h	h	?	?	h	?	t	t	t	hh	t
Nigra Plums	h	h	h	h	h	h	h	h	h	h	h	h	h
The Simon Plum	h	h	h	h	hh	hh	h	hh	hh	t	t	t	t
Triflora Plums:													
Abundance	h	h	h	h	hh	h	h	h	h	hh	hh	hh	t
Burbank	h	h	h	h	h	h	h	h	h	hh	hh	hh	t
Satsuma	hh	h	h	hh	t	h	hh	hh	hh	t	t	hh	t
Kelsey	t	?	t	hh	t	t	t	t	t	t	t	t	t

The Nigras are the hardiest of all plums. The Americana group is next, followed by the Damsons and such varieties of Domestica as Arctic, Lombard and Voronesh. Generally speaking, it may be stated that the Domestica group of plums are less hardy than the apple, but are about as hardy as pears. Probably the least hardy of the Domesticas are the Reine Claude varieties and Bradshaw. The Triflora plums, or Japanese, vary in hardiness, but as a class they are less hardy than the Domestica group, some of them being less hardy than the peach, others about the same. In the Americana group of plums there is considerable variation in hardiness.

Rain and wind. In the eastern part of the United States there is usually adequate rainfall for a plum crop. On the Pacific Coast irrigation is practiced where necessary. Winter winds are frequently a determining factor in the Mississippi Valley. In the plain regions none but the native types are able to survive. The weather at the time of bloom is a most important factor. If there is warm, dry weather during bloom time, there are usually good crops of fruit. In some cases varieties may be selected with reference to the time of bloom so that they may escape unfavorable conditions.

Soil. Plums are grown on many soil types, the chief requirement seeming to be that of good drainage. Certain varieties will stand more water than others, and may be propagated on stock which will stand water. In the Eastern states, taking New York as typical, the Domestica types are usually grown on rich clay loams. These soils are best adapted to the plant. The Triflora group is better adapted to light soils, sandy or gravelly loams, such as would be favorable for peach production. The Hortulana and Munsoniana plums appear to prefer the light soils rather than the clay loams.

Propagation. In the eastern part of the United States, the Myrobalan stock is almost in general use although some nurserymen propagate Japanese varieties on peach stock. The Americana varieties are grown on some Americana species. For the Mississippi Valley and the Southern states, probably the peach stock is preferred, but some of the Domesticas do not unite well with it. In the northern portions of the Mississippi Valley, the plums are worked on Americana stocks. In this section none but native plums are grown. On the Pacific Coast Myrobalan stock is used most frequently while the peach and the almond are mentioned as desirable for certain conditions in California. Taking the country as a whole, the Myrobalan leads as a stock, being used almost exclusively where the Domestica type predominates, followed by the peach. Native stocks should be used for native varieties, especially in the North Central states. Buds or grafts may be used. Budding is most common. In the East, with Myrobalan stock, it is done in July and August. With peach and almond stocks, budding is the only course advised. The trees are grown one or two years in the nursery and sold as one- or two-year-old trees.

Plum stocks grown from seed show marked variation in vigor and there is opportunity for considerable work to determine the stocks best adapted to varieties. Some varieties do better, at least in certain places, on their own roots.

The Myrobalan stock is cheap, usually imported from France, where the trees are raised from seed. The stocks are easily budded and make a good union with nearly all varieties. The trees grown in the nursery are of good size and handsome in appearance at two years of age. Some are not as vigorous as is desirable for certain varieties when they come into bearing. The stock is not hardy enough for the coldest parts of New York or sections having like conditions.

The St. Julien stock was in use some years ago, but is not in common use now. The stock is expensive, frequently being unobtainable in France. It is much more difficult to bud. The trees do not make as good growth as those on Myrobalan stock, and the stock is more subject to fungi while growing in the nursery row. The advantages claimed for this stock are: trees on St. Julien roots are longer lived, more thrifty, hardier, deeper rooted, show a wider degree of adaptability to soils and sucker less.

Peach stock is used on warm, sandy and gravelly soils suitable to the peach. Plums growing on such soils come into bearing early and the stock does not sucker. The stock is quite cheap, and for the Triflora plums, the root is about as hardy as the top. For some of the Domestica plums, the peach stock is not as good as Myrobalan. The union is not always satisfactory and the peach root may not be as hardy as the trunk. The varieties which are said not to make a good union include Lombard, Damsons, Yellow Egg, Washington, etc. In addition, the borers may destroy the peach root.

The Marianna stock is used in parts of the South. It is easily propagated from cuttings and is a popular stock there.

The sand plum may be used for dwarfing larger growing species, although for dwarfs the Western Sand Cherry (*Prunus besseyi*) may be used.

The almond is used on warm, loose, rocky soils in the foothills in California.

To top-work. Those desiring to top-work Domesticas will probably find the Lombard one of the best stocks. The top-working may be done by budding in late summer, or by grafting in early spring. The sooner it is done after the tree is planted the better. Trees may be top-worked at the time of planting if so desired. Trees which have had their tops injured may be top-worked to replace a limb.

Pollination. A variety may be capable of self-pollination in one location and not in another. Certain plums do not seem to be capable of pollenizing themselves anywhere. They are self-sterile. It is thought that the pistils are not receptive at the time the pollen is available. This is perhaps true in some places and not in others. The pollen of some varieties seems to be of more value for fertilizing purposes than others. Dorsey, of Minnesota, states that unfavorable weather at bloom time may completely prevent the setting of fruit in the plum even though there is a full bloom.

Factors affecting pollination. The experiments of Waugh show that wind pollination is insufficient, even under the most favorable conditions. Dorsey shows that wind is indirectly injurious because it interferes with the movement of bees and other insects. Bees do not care to travel when the temperature is below 60° F. The lowest temperature for them to take flight is stated to be 45° F. Frosts during bloom injure the pistil more than the pollen. Rain does not seem to burst plum pollen nor to kill it, but prevents its dissemination by closing the anthers or by preventing them from opening. The greatest damage from low temperature, however, seems to be due to the retarding of the pollen tube growth. In fact, the growth of the pollen tube seems to be relatively slow in the plum even under favorable conditions, and, should any factor interfere, it may prevent pollination by inhibiting the tube growth.

Pollen. Dorsey showed in his experiments that the stigma of plums was receptive for from four to six days, while the style ceases to function in from eight to twelve days after bloom. The pollen tube grows down the style to reach the ovary. If the style dries before the pollen tube reaches the ovary, pollination does not take place. In one season, rain may be the limiting factor by preventing a dissemination of pollen. In another, low temperature during the period of tube growth may prevent pollination, so that one of the remedies for this condition may be the determination of suitable pollenizers or those in which the pollen tube makes a rapid growth.

Good pollen bearers. Generally speaking, the Americana and Nigra plums bear the most pollen. The Munsoniana plums are abundant pollen bearers. The Triflora plums bear less than the others named. The Domesticas produce pollen abundantly, while the Hybrids are quite variable, some producing considerable and others little pollen. The above seems to be true under New York conditions, but Hedrick recognizes that the amount of pollen which the flowers of any tree may produce is apt to be modified by the climate, the weather and the vigor of the tree.

Sterile varieties in California. As the result of five years' observation, Hendrickson reports that in California the following varieties of Japanese plums are self-sterile: Combination, Kelsey, Satsuma, Burbank, Wickson, Sultan, Abundance. Climax is at least partly self-sterile. These varieties were capable of pollenizing each other. They were not inter-sterile. In European plums, Clyman, Tragedy, Grand Duke, Robe de Sergeant (Agen) and Sugar prunes are self-sterile. Imperial is practically so. They are not inter-sterile.

Planting. The distances used in planting vary from 12 feet to 20 feet, each way, depending on the variety, soil and conditions. Some of the weaker growing varieties, such as Damsons, may be planted close together, the trees being kept headed back; in other localities it may be wise to give them 20 feet. For the prune, 20 feet may be necessary, even 22 feet is used by some growers. Usually varieties are planted in blocks. If a pollenizer is necessary, it is advisable to put one or two rows out of every six, rather than distribute single trees throughout the orchard.

Size of tree. Generally speaking, trees two years from the bud are planted, but one-year-old trees are equally satisfactory. The year-old trees permit of the head being formed lower than is possible with two-year-old trees as usually headed in the nursery. In the past, most two-year-old trees have been trimmed up to 3 feet, but with a variety as Reine Claude, especially under eastern conditions where the trunks are apt to be affected by sunscald, it is best to start the lowest branch on the southeast side of the tree, at 18 inches from the ground, and distribute the head between that height and 3 to 4 feet.

Forming the head. In the East with the Domestica types, the head usually consists of a central trunk and four or five well-distributed main branches. In the Trifloras, the head is vase-shaped, the leader being removed and the tree made to grow as outlined for the peach. Low heading is desirable in all cases.

Pruning. Frequently pruning consists of removing the limbs or branches that are apt to cross, and heading-in of long growths. Some growers shear the trees back, handling them in about the same way as the peach. It is unwise to over-prune. The more one prunes, the more one must. The tree should be kept sufficiently open that the fruit may be gathered with a minimum of effort. In the East, the trees should be given very little pruning until they come into bearing, preferably none, and this appears to be true in other places also.

Pruning the prune. To the commercial grower the bearing prune has three types of wood: (1) The upright, strong branching or staghorn wood. This wood has not yet done its work. It has a bright future. It is just beginning to bear. It will bear the large prunes and the most of them. (2) Wood which is growing horizontally. This is the wood which has borne the crops in the past; it is of fair value for present use but has no future value. The prunes formed are not only apt to be fewer in number but also smaller in size. (3) Wood which is dropping. It has done its work. It has a past, no future. If it bears a few prunes, they are small and of inferior quality.

To prune. (1) Remove all dropping wood whenever it is seen; break it out by hand; get rid of it. (2) Keep plenty of staghorn wood coming into the tree, and when a vigorous shoot starts remove old wood near it and give it a chance to develop. (3) Weak, old trees may be pruned to encourage the development of staghorn wood, but it will usually take four years to get such wood into business. With proper pruning a tree can be kept vigorous without losing three or four crops. If a tree is weak and it is desirable to invigorate, remove half the fruit spurs. Pruning and renewal of the top is sometimes practiced. Very little hand thinning is done in commercial prune orchards in the West. The pruning takes care of the thinning.

East and West. The prune tree in the East and the prune tree in favored sections of the West are entirely different trees. In the East, the trees grow much more slowly, are not so tall and are longer lived. They are later in coming into bearing. If a tree bears a commercial crop when eight years planted, it does well. It may stay in good bearing condition for thirty years or more. In the West, the tree may be 7 feet tall when one year set, and will be a commercial tree at four years of age. The wood growth is phenomenal. The crops will be so great that the trees have to be tied together with twine to prevent tearing apart. The trees are apt to be short-lived in some sections, although in others forty or fifty years are anticipated. In certain regions, however, by the twelfth year heart rots are apt to have penetrated the trunk of the tree to such an extent that its life is impaired or the tree will be unable to support its load of fruit. It is possible that more care in looking after the trees may overcome this trouble. One may say that the prune tree saunters through life in the East, but gallops through in the West.

Thinning. In the Trifloras, the fruit is borne on the growth made during the previous season. Heavy crops, therefore, may be reduced to some extent by the removal of wood as in the peach. It is sometimes of decided benefit to thin the crop so that the fruits do not touch. Thinning should be done soon after the June drop. It is more often necessary with the Triflora and the Americana types than with the Domesticas, although frequently with a variety like Lombard it would be better if one-fifth to one-half of the fruit were removed. Thinning should be a regular practice.

Cultivation. The best plum orchards receive tillage. This consists of an early spring plowing which is usually quite shallow, and frequent cultivation until perhaps the middle of July or August, at which time a cover-crop is sown which may consist of one of the clovers, oats, barley, buckwheat or other crop. The plum requires an abundant supply of moisture, much more than the cherry, and it would almost seem to need more than the peach. Hence, the necessity of planting only on rich soils which have power to retain an adequate supply of moisture.

Fertilizers. If the orchard is on the best of land and is maintained in good tilth with the aid of cover-crops, there may be no need to fertilize. In some cases manure is applied. In others, fertilizers may be used to encourage the growth of a good cover-crop. One should carefully determine whether he needs to fertilize or not, and be guided by the results. A plum tree bears a prodigious amount of fruit if well fed and properly cared for.

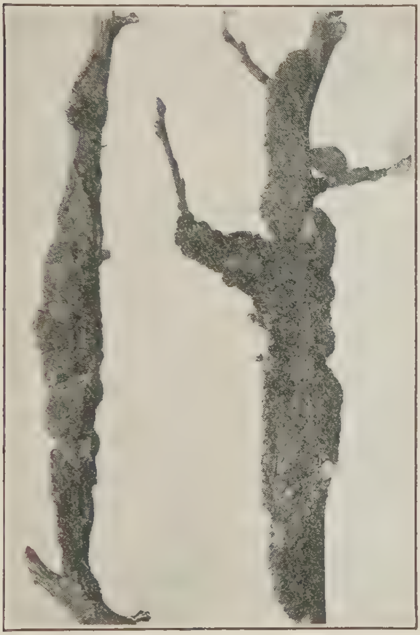


FIG. 101. Black-knot on Plum

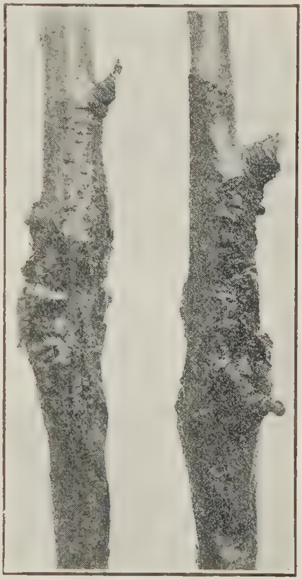


FIG. 102. Brown-rot Cankers on plum twigs, similar injury is seen on the peach

Diseases. Black-knot (*Plowrightia morbosa*) is an American disease, found in practically all of the plum-growing regions of the continent. Its presence is usually manifest by the black, hard, brittle knots or growths which appear on the limbs or twigs of the tree. Had these been noticed earlier in the summer, the enlargement would have been seen to be dark greenish, soft and velvety, but, as the season advances, it changes and assumes the winter form. The remedy is to remove the diseased wood as soon as noticed. Community action is necessary to clean up this disease. No varieties are immune. The Trifloras are less subject to attack than any other group. The Damson group is next. Some of the Domesticas are less subject to attack than others.

Brown-rot (*Sclerotinia cinerea*) attacks the fruit, flowers, shoots and leaves. Sometimes the latter appear as though blackened by frost, and the crop may be wiped out over night. The Trifloras and the native plums are more subject to attack than any other species. For control, see peach.

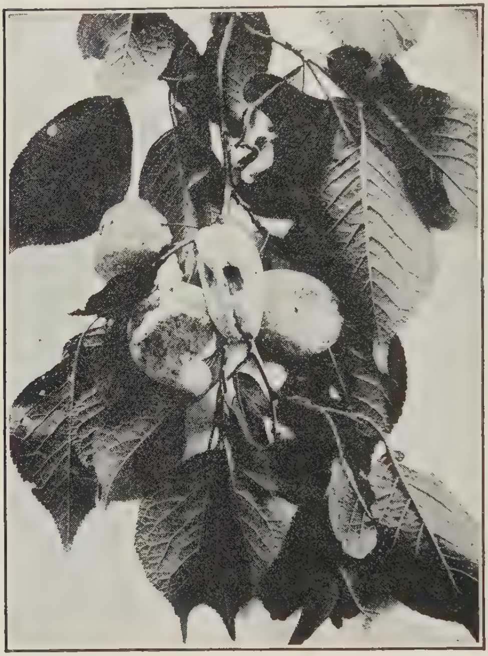


FIG. 103. Plum Pockets or Plum Bladder on the fruit. The fruit is worthless and falls off. A tree once attacked may continue to produce fruit of this character. Spray with bordeaux mixture or lime sulphur before the buds open *Cornell Univ. Agr. Exp. Sta.*

Plum-pockets (*Exoascus pruni*). This fungus disease causes deformity of the fruits. It appears at an early stage of their growth, causing the production of a spongy mass in the fleshy tissue which enlarges and distorts the plum. The pit may not develop. The leaves frequently show more or less red or yellow with a decided curling. Later the shoots become affected and appear as a rosette of malformed leaves. Munsoniana and Hortulana plums seem to be most susceptible. The remedies suggested at present are the removal of the affected branches or twigs and spraying with lime sulphur, 1:50, or bordeaux mixture just before the buds open in spring and after the petals fall.

Leaf blight, shot-hole fungus (*Coccomyces prunophoræ*). Use lime sulphur as described under Cherry.

Powdery-mildew (*Podosphæra oxyacanthæ*) is sometimes seen as a grayish powder on the leaves. Spraying with lime sulphur or same with iron sulphate will usually control.

Gummosis as seen in the cherry may attack the trees.

Sunscald is sometimes seen on the trunks. The wound may be infested by fungi which cause more or less gumming. The best control perhaps is to head the tree low, taking care that there is a limb started fairly low on the trunk on the southeast side of the tree which will shade the trunk during the winter when the sun shines during the middle of the day. The cracking of the bark in many instances is probably due to the rapid thawing of part of the trunk, due to the action of the sun's rays while the rest of the tree is frozen, this cracking paving the way for gummosis. Reine Claude and the Triflora plums are most frequently affected by sunscald; Lombard least so.

Rust (*Puccinia pruni-spinosæ*) is not uncommon. Treat as for Leaf-curl in Peach.

Scab (*Cladosporium carpophilum*) sometimes affects the tree. (See Peach.)

Black spot (*Bacterium pruni*) is sometimes prevalent. (See Peach.)

Pear blight, peach yellows and peach rosette are all destructive to the Triflora plums and sometimes to the Domesticas.

Leaf-curl sometimes attacks the Italian Prune in Oregon and Washington. This causes the leaves to curl and shrivel. No remedy is given.

Armillaria Root Rot injures the prune seriously on the Pacific Coast.

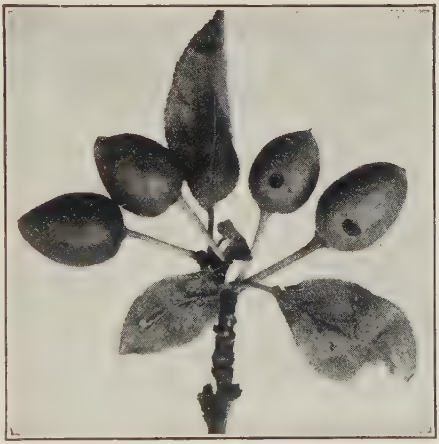


FIG. 104. The well-known sting of the Plum Curculio on young plums. Many other fruits are injured in this way
U. S. D. A.

Insects. **The Plum Curculio** (*Conotrachelus nenuphar*), a snout-beetle about one-quarter inch long is familiar to the plum grower. The female punctures the skin of the young plum in which she deposits an egg. Above this she makes a crescent mark. In the course of a week, the larva emerges from the egg and burrows to the stone, making a wormy fruit which usually drops before reaching maturity. The treatment is to clean up all rubbish around the orchard which might give a hiding-place for the beetles and to spray with arsenate of lead, using 2 or 3 pounds of paste to 50 gallons of water, or half the amount of powder, coating the foliage and fruit thoroughly as soon as possible after bloom. (See Peach Spraying schedule.)

The Plum Gouger (*Coccotorus scutellaris*) is a larger snout-beetle than the curculio and frequently damages plums. The maturing insect punctures the skin and deposits an egg from which the larva emerges and penetrates and usually infests the stone, thus differing from the curculio, the larva of which usually infests the flesh. The treatment is the same as for curculio.

Borers. The peach borer is one of the troublesome pests of the plum. The following borers also attack the tree in one place or another: the lesser peach borer, the flat-headed apple-tree borer, the shot-hole borer, the American plum borer, the peach bark-beetle. (See Peach and Apple.)

The Plum Plant-louse (*Myzus mahaleb*) is sometimes quite destructive. The cherry aphis, green peach aphis, and in some cases the rusty-brown plum louse and the mealy plum louse attack this fruit. (For treatment, see Apple Aphis.)

San José scale is probably the most serious of the scale insects. The European Fruit Lecanium is sometimes quite destructive. The same is true of a large number of other scales. Miscible oils will usually control.

The Apple-tree Tent-caterpillar. Wild plums are often severely attacked by this tent caterpillar, but the cultivated plums, when taken care of, are usually relatively free. Spraying with arsenical poison, especially if one sprays to control curculio, will usually control this pest. The same treatment is given for the spring canker worm and the fall canker worm. (See Apple.)

Bud-moth and Case-bearers also attack the buds. (See Apple.)

Spraying. Many insects and diseases which attack the peach are found on the plum so that the spraying program outlined is practically the same in both instances. If San José scale is present a dormant spraying of lime sulphur, 1 to 8, may be given. Incidentally this will be of value in the control of the brown-rot. A second spraying is in order as soon as the trees are out of bloom and about the time the plums are the size of a pea. This spray should contain arsenate of lead, 1 pound powder to 50 gallons of water, and either a weak bordeaux mixture, 2:3:50, or lime sulphur, 1:50 with 2 or 3 pounds of hydrated lime, or self-boiled lime sulphur or atomic sulphur. Subsequent sprayings with self-boiled lime sulphur will be necessary to prevent brown-rot in the Triflora and the Americana types. Lime sulphur, 1:50, is frequently of decided benefit to the fruit and foliage of the Domestica types. Sometimes two or three summer sprayings are given at intervals of a couple of weeks. Dusting with sulphur may also be used and both peaches and plums may be dusted with advantage a day or two before harvesting; it greatly increases their shipping life.

Age of Bearing. In the plum-growing regions in New York, trees come into bearing anywhere from three to seven years after planting. The Triflora varieties often come into bearing at three to five years after planting. The Domestica type bears at from four to eight years, while the native varieties take longest. When eight to nine years old, varieties such as the Italian prune will be in good bearing and produce as much as three bushels of fruit per tree per year. About four tons per acre or a little less than a bushel and one-half per tree is an excellent crop under New York conditions as the average of an orchard. In California a bushel of fruit may be had when the trees are four years old and from 150 to 300 pounds at six or seven years old. Two hundred to 300 pounds per tree are a good average crop. Much higher yields are secured from exceptional trees.

Time of harvest. In the Eastern states plums are usually harvested just before they are eatable—that is, while they are still somewhat green. This is done for certain reasons, as follows: (1) They are easier to handle. (2) The brown-rot fungus is apt to attack the crop if left until fully matured. (3) If used for canning, or in the case of prunes which are used for jam, the flavor of the jam is much better if the plums are not fully ripe. In the case of the Triflora varieties, such as Abundance, Burbank and October, the idea is to harvest at least a week to ten days before the fruits are fully ripe.

Package and harvesting. The package used depends upon the market. If the crop is sold to a canner, the fruit is gathered in any handy picking basket, poured into bushel baskets without sorting, and delivered to the cannery as fast as harvested. If to be shipped, it is hauled at once to an iced car or to cold storage where it is promptly cooled. In the East when the fruit is to be shipped to market it is usually harvested in four. eight, or ten-quart Climax baskets, depending upon the market. If the crop is light the smaller package is preferred. The fruit is hauled to the packing-shed where it may be graded, and is immediately placed in cold storage until needed.

Much of the crop grown in the Eastern states is purchased by canners or jam-makers so that little attention has been paid, generally speaking, to the use of small packages and the wrapping of individual fruits as is sometimes seen in fruit shipped from the Western states. There is a possibility of working up a trade in fancy dessert plums which might be packed in small baskets, but so long as the growers can get remunerative prices and let the whole crop go to the cannery, they prefer to do so. The harvesting of prunes is treated elsewhere.

Harvesting and packing plums in California. For long distance shipment plums are harvested as soon as hard ripe. Frequently three to five pickings are made. Care is taken in handling. Even the bloom on the fruit is disturbed as little as possible; it adds to the life of the fruit. Plums are packed in the same size crates as apricots. Two types of crates are used—the solid-side crate, which is preferable because it is stronger. and the eight-slat crate which is frail. The crates are stamped with the variety and the size of the pack, the name of the grower and the minimum net weight of the fruit. Baskets are used to hold the fruit. These have sloping sides, are approximately 8 inches square on top, 6½ inches on the bottom, and 4 inches deep. They are made of thin veneer, the top edge being strengthened with a piece of tin. Four are used to each crate. A strip of tissue paper 7½ inches wide by 32 inches long is used in packing the plums, being folded over each layer, although in some places a thin veneer or pasteboard shim is placed between each layer of fruit instead. Special packs have been worked out for each size of fruit, the aim in sizing being to have not more than one-quarter inch difference in the size of the fruit in the top and bottom layers. Some of the large plums pack 3 by 3 in the bottom layer and 3 by 4 in the second and third, while smaller fruits may pack 5 by 6 in the bottom and 6 by 6 in the other layers. The crates have an estimated weight of 26 pounds. A carload is 1,000 crates, consisting of ten tiers of five crates wide and nine high on one side of the doorway, and eleven tiers on the other side.

Storage. If properly handled, almost any variety of the

Domestica type can be stored for a month and some of the prunes can be stored for three months. Plums will retain their shape in storage long after they have lost their flavor. Varieties such as the Damsons will be absolutely lacking in flavor before they begin to decay.

The best storage plums. Experiments with California plums show that plums held at a temperature of 32° F. will keep one to three weeks longer than if held at 36° F. The best-keeping varieties are Kelsey, Grand Duke and Wickson. When held in storage for 90 to 111 days Wicksons held up for five days after being taken out of storage. Satsuma, Agen (French Prune), Yellow Egg and Tragedy, all high-quality fruits, held their flavor when stored 65 days and the last one 88 days and remained marketable for a week to ten days after removal from storage. Imperial, German Prune, Pond, Climax, Sultan and Sugar kept well in storage for sixty days, some of them longer, and remained in marketable condition for three to five days after removal from storage. Beauty, Botan, Abundance, Burbank, Combination, Peach, Clyman, Washington and Columbia kept fairly well for four to five weeks in storage, but some of them lost quality and they are apt to soon spoil after removal from storage.

The indications are that certain varieties such as Kelsey, Wickson, French, Grand Duke and Satsuma might be moved by boat from California through the Panama Canal to Eastern seaboard under refrigeration at a temperature of 36° F., also that cold storage may be used at terminal points sometimes with advantage in the case of plums. For example, in New York on August 17, 1920, with a total receipt of 6,930 crates, the average price paid per crate was $2.66; on August 19, the receipts were 5,838 crates and the price $2.83 per crate; on August 20, the receipts were 170 crates and the average price per crate $4.37, a difference of $1.54 per crate between two successive days as the result of differences in the supply. High prices prevailed from the twentieth to the twenty-fifth of August, on account of short supply.

Drying prunes in Oregon and Washington. The prunes of Oregon and Washington are dried by artificial heat, those of California are dried in the sun. The prune is allowed to ripen on the tree until it drops, either with or without a light shaking. The fruit is picked from the ground in bushel boxes, the common yield being 1,000 to 8,000 pounds per acre. The fruit is hauled to the evaporator and dried as soon as possible for fear of brown-rot which may attack the fruit.

Two types of kilns are used where kiln drying is practiced—steam and hot air. The hot air method is used in both the tunnel and the stack drier. Briefly stated, the fruit is washed and graded and then dipped into boiling lye (1 pound to 30 to 50 gallons of water) which checks the skin of the prune, and lets the gases escape, thus facilitating drying. Boiling water sometimes is used instead. The prunes are then dipped in cold running water to clean them and are run into the driers, starting in at a temperature of 125° F. and finishing at about 135° F. Usually about 36 hours are required to dry the fruit, depending upon the degree of maturity and other conditions. Formerly higher temperatures were used but such are detrimental. The fruit is then stored in bins to sweat, after which it is processed or steamed, which makes the prunes soft and easy to pack. While still warm they are packed in the fifty-pound boxes in which we see them in the stores. The boxes are labelled and made attractive to show off the goods.

Drying in California. The fruit is allowed to drop naturally, until the last picking, when the trees are shaken. The fruit is gathered weekly and harvest is completed in a month. The fruit is put through a lye bath and is run over a pricking-board to hasten drying. It is graded into three sizes and placed in trays 8 feet by 3 feet in the drying yard. The fruit remains in the sun until about three-fourths dry. It is turned over at least once. The trays are then stacked in piles of about twenty to finish drying. The process takes ten to fourteen days. The fruit is then graded over screens, weighed and counted. If it is time to pack it, it is processed by dipping in boiling water, after which it is washed and packed in the package. These run from 1 pound to 50 pounds in capacity. Dehydration, owing to the greater certainty of operation and better grade of product, is replacing sun drying.

Selling Prunes. Prunes are sold by size. The price is based on the number of prunes in one pound. Thus 30 to 40 are large prunes, and usually command the highest price, while 100 or more command the lowest price. When prunes are sold "bulk basis" it means that the so-called base price is the price which is to be paid for the prunes which weigh 75 to 80 to the pound. Thus, if the price is 2 cents "bulk basis," it is 2 cents a pound for all prunes of 75 to 80 count with a premium for all larger, and a discount for all of lesser size. It pays to grow large size fruit.

PART III

THE GRAPE

CHAPTER XXXVIII

THE GRAPE

Although grapes (*Vitis spp.*) are found growing over the greater portion of this country, at present nearly two-thirds of all the commercial-bearing vines are in California. That state produces over 75 per cent of the total grape crop, but in value is about 50 per cent of the total. New York and Michigan are next in rank.

European grapes failed in America. European and other grapes were brought here in profusion, but they dwindled and died. After two centuries of such experience men began to realize that they must rely on the native grapes, of which there are so many, and the past sixty or seventy years have witnessed the development of our native grapes. The great achievement is not the improvement in grapes merely, but the public taste has been developed to call for grapes to eat out of hand. The reason the European grapes failed in the East was in part from winter injury, but mainly due to black rot and mildew. Any schoolboy may now know about them, and if he sprays with bordeaux mixture he can control these diseases of the grape.

Phylloxera. The Phylloxera was another obstacle. It is a small louse which lives on the root of the European grape, in fact on the root of all grapes. It saps the life out of the European plant, while our native river bank grape (*Vitis riparia*) is immune to its attacks. Millions of cuttings of this wild grape are now in use both in Europe and in California as stocks upon which to graft the European grape; that is, the root of the plant is the river bank grape and the top any desired variety of European type. Failure to recognize and control these diseases forced the development of our native grapes, and led to the development of a great grape business.

There are many species of native wild grapes. Important ones are as follows:

Labrusca (*Vitis labrusca*) or Fox grape is indigenous in the Eastern states and is the parent of many cultivated grapes—Concord, Catawba, Worden and Niagara. Its berries tend to shell from the stalk. The shelling which is so often seen in some of our grapes has probably been inherited from this parent.

Aestivalis (*V. aestivalis*) is the Summer, Bunch or Pigeon grape. It is found from New York to Florida and west to the Mississippi. It has given rise to more varieties than any other except Labrusca, and its varieties are pre-eminent for wine-making. Prominent among its varieties are Herbemont, Lenoir, Virginia and Cynthiana—all prominent southern wine grapes.

Riparia (*V. riparia*) is the Riverbank or Frost grape. This is the commonest grape in the Northern states, west of New England. It is valuable because its roots are immune to Phylloxera, and named varieties of it are used as the roots for European grapes, both in California and in Europe. It has given rise to such varieties as Clinton, Elvira, Pearl, etc.

Vinifera (*V. vinifera*). This is the old-world wine grape. It is grown in California, and can be grown in New York out of doors if grafted on native roots. It has been used to hybridize with native grapes, some of the best-known of these being the Roger's Hybrids. Two of the well-known hothouse grapes of England, which can be tried out of doors in the East are Muscat of Alexandria and Black Hamburg.

Rotundifolia (*V. rotundifolia*). This is the southern Fox grape or Muscadine or Bull grape. It grows on river banks and in thickets from Delaware south, and is best known because it is the parent of the Scuppernong. It is claimed that the Scuppernong was discovered on Roanoke Island by Sir Walter Raleigh's colony, and that the original grape is still in existence. It is used for wine-making, and hybrids of this and other grapes are the basis for the southern grapes.

Location. One must be located exactly right for the variety he hopes to grow. The same variety will vary materially when grown in different regions. A variety may be a success in one part of a town and a failure in another part of the same town; it may succeed on one side of a lake but not on the other, or on one slope of a hill and not on the other. The only real test is to try a variety. Nothing else is proof of the suitability of a locality to a particular variety.

Two factors enter into location—latitude and altitude. The grape which has been produced for southern conditions may not ripen in the North. Varieties produced for northern conditions may ripen too quickly in the South. The variety must be adapted to the location, to the length of the growing season, to the amount of sunlight available in that location. to the temperature of the air, and to soil conditions. The presence of bodies of water or other modifying influences affect the selection of the location. The grape needs an equable climate, where there is not much difference in temperature between the nocturnal and daily range. Thus in New York, where there is an average temperature of 55 to 65° F. from May to July, and 65 to 75° F. from August to October, are offered good conditions for grape growing. The commercial plantings in New York are in the Chautauqua region by the shores of Lake Erie; the Finger Lake region on the shores of the Finger Lakes; the Ontario region on Lake Ontario, and the Hudson River region on the banks of that stream; in Michigan, on the shores of Lake Michigan; and grapes do well in the equable climate of the New Jersey, Delaware and Maryland peninsulas in the East, and in California on the Pacific Coast. For home use the grape can be planted over a large portion of the United States provided the right variety is used.

Climate and soil. The grape shows marked drought-resisting ability. The rainfall must be adequate and it may easily be excessive. The best quality fruit is grown and it is most free from fungi where there is a relatively scanty rainfall. An excessive rainfall forces too great a growth of vine, inhibits the proper setting of the fruit, favors certain diseases, and weakens the root system.

If the soil is too rich the plants may easily get out of hand and fail to produce fruit. Several of the wild grapes grow naturally on very poor soils. A light, friable, well-drained soil is generally preferred. A hardpan or clay soil is not desirable. Soils lacking in fertility may be enriched by manuring and the growing of cover crops, and grapes on such soils are more easily managed than those on rich soils. Under-drainage may be advisable.

Planting. Land is usually prepared by growing clover crops on it prior to planting. It is fall-plowed as a rule; it may be thrown into lands 8 or 9 feet wide, or to the distance at which the rows are to be apart. In some cases, the subsoil plow is run in the dead furrow; the soil is then thrown out again with

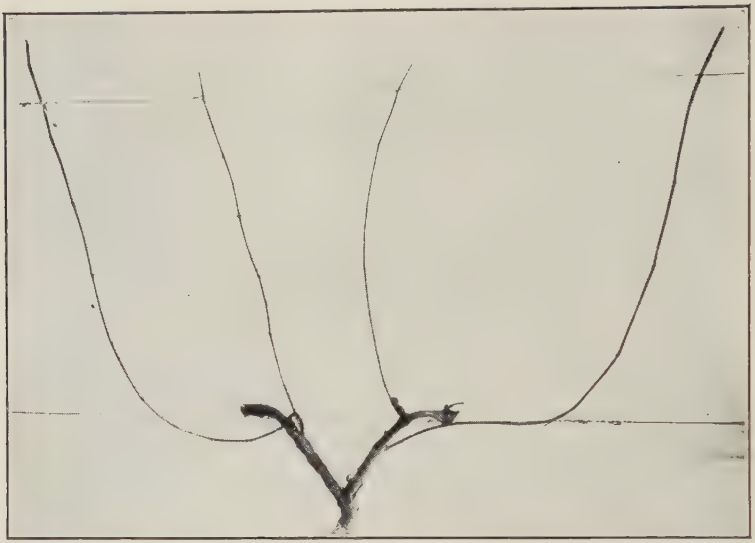


FIG. 105. The Chautauqua system of pruning used in Western and Central New York for Labrusca grapes as Concord, etc.

the moldboard plow to make a deep trench in which the plants can be set. This insures deep planting. The ideal direction for rows is north and south. Some of the older vineyards are set 10x10 feet; many others are planted 9 feet apart with the vines 8 feet in the rows; others are 8½x8 feet, because this distance may be plowed easily with a three-gang plow by going twice through the row. A wide disk harrow or spring tooth can be spread so that once down the row will do the cultivation. In the Southern states, the distance apart of the vines is usually somewhat greater than is practiced in the northern vineyards. Such weak-growing varieties as Delaware, Elvira and Gold Coin are planted 8 feet apart in the row and stronger growers as Concord and Carman are given 10 feet, while Hebemont, Laussel and Fern, which are rank growers, may be given 12 to 16 feet. The Scuppernong group often is given either 8x16 or 12x12, and sometimes even 20 to 30 feet space in rows 15 feet wide. The distance apart depends upon: (a) The soil; the poorer it is the closer the plants; and (b) the variety; strong growers need the greater area. On the Pacific Coast Vinifera grapes are grown as individuals or are tied to a stake, although the use of a trellis is advisable for some varieties. East of the Rockies they are grown on a trellis.

The roots of the young plant are usually cut back. The top is cut back to three buds. The roots are spread out in the hole, some of the surface soil is tamped firmly upon them, but the surface 2 or 3 inches is left loose. The following spring the growth is often cut back to two buds.

Chautauqua system of trellis. In the Chautauqua region in New York posts 6 to 8 feet long are used. They are sharpened and driven at least 18 inches into the ground. The lower wire is usually placed 28 or 30 inches from the ground, and the upper wire 30 inches above it. Number 9 and Number 10 wires are used; staples a little longer than used for putting up barbed wire fencing are employed. The wires are put on the windward side of the post. One post is used for every three vines, say every 27 feet. The end posts should be well braced. All posts may need to be straightened each spring.

Southern system. In the Southern states (and in some places in the North) three wires are used—the first 18 to 24 inches from the ground, the second a foot above, and the third a foot above the second wire. For the strong-growing Muscadines, posts 8 to 10 feet long are best.

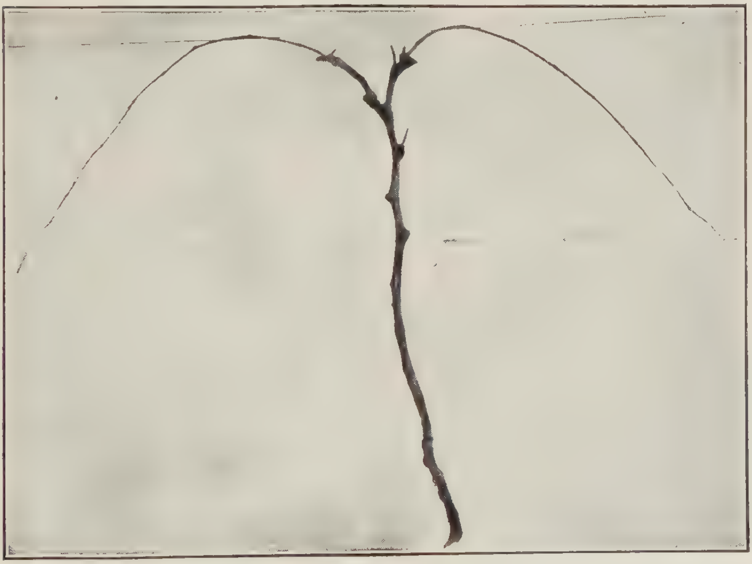


FIG. 106. The Umbrella Kniffen system sometimes used in Pennsylvania and another like it further South. The one-wire or low Kniffen is similar except that but one wire is used

Alleys. To facilitate the removal of the fruit, prunings, etc., alleys should be provided at frequent intervals, say every 50 grapevines or 400 to 450 feet. These should be 24 or 30 feet wide so that a two-horse team can turn around in them.

Propagation. New varieties are propagated from seeds. Fixed varieties are reproduced from cuttings. These are made as soon as the leaves fall in the autumn from well-ripened wood. The cuttings are usually 8 to 12 inches long and contain at least three joints. The lower cut should be made just below a joint. In some cases a short heel of old wood is left on the base of a cutting. The upper cut is made about 1 inch above the bud. The cuttings may be buried in the soil until spring or planted at once in loose, rich, light soil, usually in rows 4 feet apart and a few inches apart in the row. These will make a growth of 2 or more feet, and the following fall they are one-year-old plants. Some varieties as Concord and Niagara are easily grown; others, as Norton and Cynthiana, may start perhaps only 10 per cent. The varieties difficult to propagate from cuttings may be started by layering the canes either in early spring or late in the summer. Layering consists of digging a trench 2 or 3 inches deep and laying and burying a cane in the trench. At each of the joints roots and a shoot will form.

Grafting. The grape is easily grafted so that an undesirable variety may be quickly changed. The ordinary cleft graft is employed. This may be done below the surface of the ground if desired. The graft should be covered with grafting wax or clay to keep the water out. Vines of any age may be grafted. It is important that the scions be dormant. Grafting is best done early in spring. In the East, European varieties may be worked onto roots of a resistant type, and if laid down before the winter and given protection they may be grown quite successfully. The graft should be inserted on the trunk so that it will not root, in this case to avoid Phylloxera. In New York, Concord, Niagara and Campbell grapes are much more productive if grafted on a vigorous stock than when on their own roots.

Selection of plants. Most commercial planters prefer first grade one-year-old vines; most amateurs prefer something larger. If a two-year-old is a Number 1 plant, it may be accepted; but if it is a cull plant, and therefore unsaleable at one year-old, it may be an undesirable. Vines sold at a low price are usually low priced for a reason, and a vineyard started with poor vines is handicapped beyond repair.

Cross-Pollination. It is essential to know whether a variety is capable of fertilizing itself or not. Sterile varieties must have a pollenizer with them and should not be planted in large blocks. It will be necessary to plant a few rows of a variety which can pollenize the particular variety grown. Poor pollination means unmarketable clusters of fruit.

Cultivation. Spring cultivation consists of shallow plowing to turn under the cover crop. In plowing to the plants the first furrow near the vines may be turned with a one-horse plow, or the last furrow if plowing away. In other cases, the cover crop may be thoroughly chopped up with a disk harrow. Cultivation is maintained throughout the season to the first of August. A light furrow is then thrown to the vine and a dead furrow is left in the middle of the row. The land is then seeded to a cover crop. The tools usually consist of the spring-tooth and disk harrow, the grape hoe drawn by one horse and used for working close to the vines, and the hand hoe. The grape hoe sometimes is used to expose the rootworm when it has reached that stage of existence that it is in the upper layer of the soil and ready to emerge to lay its eggs on the canes. A furrow is thrown away from the hill and the emerging insects are apt to be destroyed by the sun.

Cover crops and manure. Those vineyards that are given good tillage, good care, and in which cover crops are grown are usually in splendid condition and are profitable. Cover crops maintain the supply of organic matter which is necessary. The cover crops may consist of the different clovers or other plants. A non-leguminous cover crop may be secured by sowing a pound of cowhorn turnips and a bushel of wheat per acre.

The value of manure is twofold: To improve the physical condition of the land and to provide plant food. Whether to apply or not will depend entirely upon whether it can be secured economically and whether or not the vines are in a condition as to make its use advisable. A good cover crop may maintain the organic matter and fertilizers may aid the cover crops. So long as the vines are doing well fertilizers are not required. If they are not doing well make sure that lack of drainage, faulty tillage or other error in practice is not to blame rather than a lack of fertilizer. In the South many enterprising growers use cottonseed meal, ground bone, kainit and acid phosphate and some use bone manure.

Fertilizers. Results of a ten-year test at Fredonia, N. Y., show that nitrogen is the most important of the plant foods. For the grape, as high as 250 pounds of nitrate of soda is applied to an acre, potash ranking second. Phosphates seem to have little effect, although they sometimes improve the cover crop. Summarizing the results, it would seem: (1) That fertilizers tend to prevent winter injury; (2) that they tend to increase the number of bearing canes, averaging 1896 canes per acre on unfertilized plants against 2,300 to 2,400 on those receiving fertilizers; (3) that fertilizers increase the yield of fruit per cane, and the fruit is of better quality; (4) that fertilizers increase the yield by over a ton of grapes per acre; (5) that they increase the financial returns by nearly $30 per acre per year. Whether it will be profitable to apply fertilizers to any particular vineyard can be determined only by trial.

Spraying. Under New York conditions, lime sulphur has not been found satisfactory as a foliage spray for grapes. Dusting with sulphur has been practiced in Europe with satisfactory results, and is used in California, but lime sulphur is not advised. A spraying program is tentative only. The custom is to spray as soon as possible after the blossoms fall, using bordeaux mixture 4:4:50, with three pounds arsenate of lead paste or 1½ pounds powder. Sometimes two or more applications are made at intervals of two or three weeks, depending upon the troubles present. Farther south it may be necessary to spray four or five times, using bordeaux mixture and arsenate of lead. Dusting with copper sulphate and lime with arsenate of lead is practicable. On the Pacific Coast sulphur is used as dust to control powdery mildew. If dusting be practiced the vines should be coated frequently, in some cases every week or ten days.

Pruning the bearing plant. The usual practice in winter pruning is to remove a half or three-quarters of the entire vine. This is done after the leaves fall, usually during the winter months. Different systems of pruning are used in the different parts of the country. Thus in New York there is the Chautauqua or upright system, which is well adapted to varieties whose shoots grow erect, as Catawba, and for slender varieties such as Delaware. Along the Hudson River, the Kniffen or drooping system has been accepted as the most desirable. It is adopted to strong-growing varieties like Concord, and is cheaper because there is no summer tying. In the Chautauqua system, semi-permanent arms are developed on the lower wire and new canes developed from these are selected and tied to the top wire. These new canes are renewed each year from buds that spring from near the base of the cane or directly from the side arms. The side arms themselves are renewed every few years by laying down new growth along the lower wire and removing as much of the old wood as possible. In the Kniffen system, the main trunk is carried to the top wire. Side arms of the previous year's growth, bearing eight to ten buds, are allowed to develop in both directions on each wire. Short spurs of new wood are later retained at the center of the vine. These side arms and spurs are renewed each year, occasionally going back to the main trunk to get them.

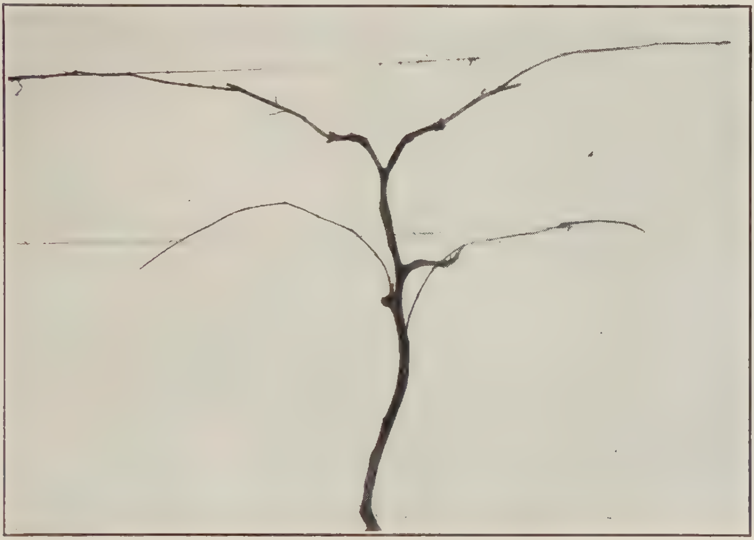


FIG. 107. The Single-stem Kniffen system, used in the Atlantic Coast states. A modification frequently seen is the Y stem Kniffen, in which the main trunk is carried to the upper wire and a sub-trunk originating about half-way between the ground and the lower wire is carried to the lower wire constituting a Y or double trunk Kniffen

Pruning vines on porches. All old wood not bearing new growth and that which bears very weak canes may be taken out. If the vine has not been regularly pruned, do not prune too severely until pruning has been established two or three years. The aim should be to cut the canes to spurs bearing from two to four buds, leaving a number of these spurs. By the use of judgment, the amount of old wood may be reduced without injuring the bearing of the vines and new canes may be made from the spurs.

Fundamentals for intelligent pruning. A few points should be considered before beginning the work: (1) All fruit is borne on shoots that arise from buds on wood of the previous season's growth. (2) Canes of medium size with plump buds give the best results, that is, very vigorous canes and light weak canes should be eliminated, giving preference to those which have vigorous buds. (3) Old wood is of value only so far as it carries young growth and should be reduced to a minimum. (4) The bearing wood should be kept as near the trunk as possible.

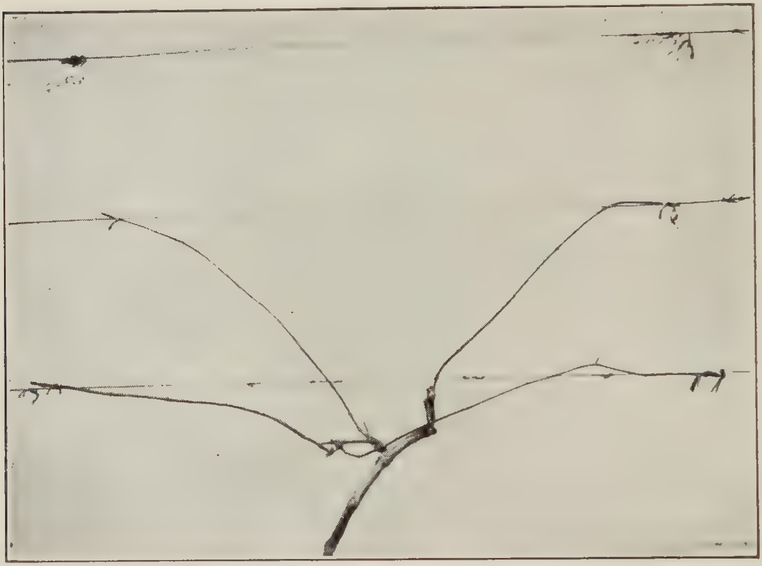


Fig. 108. The High-Renewal system in which usually three wires are used. The lowest wire is about 18 to 30 inches from the ground. The canes from the lower arm are trained on this and two others on the second wire. The bearing shoots of the lower canes are trained on the second wire and those from the upper canes on the top wire and anything that projects is cut off or pinched back

Summer pruning. Summer pruning may consist of the removal of surplus shoots as soon as the first growth starts in spring. It may be repeated at two or three intervals during the summer. It is usually accomplished by cutting or breaking off growths which are not needed. If left until the wood is firm, it may as well not be done. The sooner it is done after a shoot begins to grow, the better it is for those left. It is sometimes wise to do it to admit sunlight to the fruit.

Anthracnose (*Glœosporium ampelophagum*). So far, this disease has not caused any great loss and it is hoped that it can be confined to its present area, for its eradication is difficult. However, the spraying usually given for black rot will control, with the cutting out of the affected shoots.

Dead Arm is caused by the fungus *Cryptosporella viticola*. It is found in the East. It is carried by the pruning tools. Removal of affected parts and spraying as for black rot will usually aid in control.

Black Rot (*Guignardia bidwellii*) is one of the most destructive fungus diseases of the grape, east of the Rocky Mountains. It appears on the leaves as well as the fruit; on the leaves as reddish brown dead spots and on the fruit when it is half grown, causing brownish or black spots, which cause the berry to shrivel and die. The dry mummies hang to the vine. These give off the spores and carry the disease over the winter. Thorough spraying with bordeaux mixture about 4:4:50 formula, as soon as the plants are out of bloom, giving three or four applications, is advised.

Downy Mildew (*Plasmopara viticola*) sometimes causes as much damage as black rot. The white downy growth looking like hoar frost may be seen on the under side of the leaves. The fruit is also attacked and drops off. Spraying as outlined for black rot will control it.

Powdery Mildew (*Uncinula necator*) has caused some damage in the Northwest. It is more serious on the European varieties. Dusting with the finest sulphur is advised, as soon as the plants are out of bloom and again as soon as the grapes start to form and perhaps two or three times later. The use of lime sulphur on grape vines is apt to be disastrous. Bordeaux mixture as suggested for black rot may control.

Ripe Rot or Bitter Rot attacks the stems, leaves and fruit.

The disease is allied to the one which causes bitter rot on the apple. Spraying as outlined for black rot should prevent it.

Anaheim disease is sometimes called the California vine disease. It is doing considerable damage in California to the European grapes. The cause is unknown.

The California Grape Root-worm (*Adoxus obscurus*) is hatched from eggs laid by a beetle. The larvæ live on the roots and damage by eating them. Thorough cultivation to the base of the vines kills many of them, and spraying the foliage as soon as well formed with arsenical sprays is advised, using 10 pounds paste arsenate of lead in 100 gallons of water.

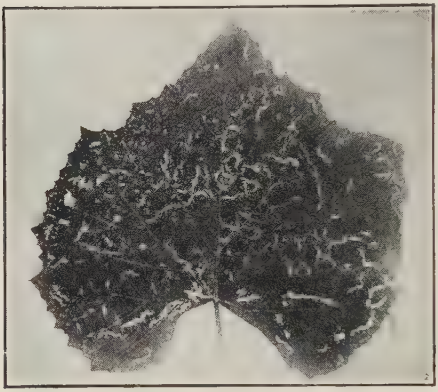


FIG. 109. The work of the adults of the Grape Root Worm on grape foliage
N. Y. (Geneva) Agr. Exp. Sta.

The Grape Root-worm (*Fidia viticida*) is most destructive east of the Rockies. The beetles feed on the leaves before egg-laying, hence spraying with arsenate of lead 6 pounds in 100 gallons of water is advised, repeating in ten days. The insects pupate in June and constant stirring of the surface soil at this time will destroy many of these pests.

Erinose disease appears as swellings on the upper surface of the leaves with depressions on the lower surface, the leaves fall off to the detriment of the plant. On the under-surface the depression carries a thick felt-like covering; it is white, which gradually turns brown. It is caused by a minute mite (*Eriophyes vitis*). Some of the American varieties, as the Scuppernong, are immune to it, but all the European grapes are susceptible. The fumes of sulphur are destructive to the mite. Thorough dusting of the vines as suggested for powdery mildew will control the trouble.

The Grape-berry Moth (*Polychrosis viteana*). The larvæ attacks the berry or fruit of the grape. It appears to live wholly on this plant. The insect is quite small, not over one-half inch with its wings expanded; the eggs are laid on the blossom clusters or on the young grapes. The larvæ feed on the blossoms and young berries, fastening them together with a web. A second brood infests the grapes during July and August. Control is in the use of arsenical poisons against the first brood. This should be made just before the blossoms are ready to open, with a second spraying after the blossoms have fallen, and a third ten days later. The latter two coincide with the first and second treatments for the grape-root worm.

The Grape-blossom Midge (*Contarinia johnsoni*) is a very tiny fly which sometimes plays havoc with the crop, the eggs being laid in the open flower bud. The insects cause the blossoms to fail to set fruit. One or two early sprayings with nicotine is the only remedy suggested, spraying as the early blossoms begin to open.

The Grape-cane Borer has long been known as the apple-twig borer. It also attacks the peach, pear, plum and other trees. It is very destructive to the grape from the Central West to the Gulf states. The only remedy seems to be to remove all wood in which it is breeding.

The Grape Curculio (*Craponius inæqualis*) works on the grape in the same way that other curculio do on other fruit. The beetles feed frequently on the foliage in the spring so that early sprayings with arsenical poisons which are applied for other insects will practically control this one.

The Grape Leaf-folder (*Desmia funeralis*) is readily recognized by its habit of folding or rolling the leaves. The larvæ feed by eating off the upper surface of the leaf, thus skeletonizing it, or by feeding on the leaf from the free edge. Spraying with arsenical poisons is advised.

The Grape Leaf-hopper (*Typhlocyba comes*). This insect is very small, something like one-eighth of an inch long. It feeds on the foliage of the grape. The most effective spray is a nicotine solution, which should be applied as they begin to appear about the first of June. A 25 per cent calcium cyanide dust proved equally effective but burning of foliage may occur if the foliage gets wet soon after the dust is applied.

Phylloxera (*Phylloxera vastatrix*) is a root louse which produces galls on the roots. It lives on all varieties of grapes, but does more damage to the European varieties. The remedy is to plant stocks which are immune and graft on these the variety which it is desired to grow. Care should be taken to be sure that the variety desired will grow well on the stock before doing extensive work in top-grafting.

The Grape Scale (*Aspidiotus uvæ*) is controlled by a lime-sulphur dormant spray the same as for San José scale.

The Grape-vine Flea-beetle (*Haltica chalybea*) is controlled by spraying with arsenical poisons. Nicotine dusts are also used.

Rose Chafers and Grasshoppers sometimes attack the plants. For the former, applying a spray made of 10 pounds of paste arsenate of lead, 25 pounds of glucose in 100 gallons of water is advised.

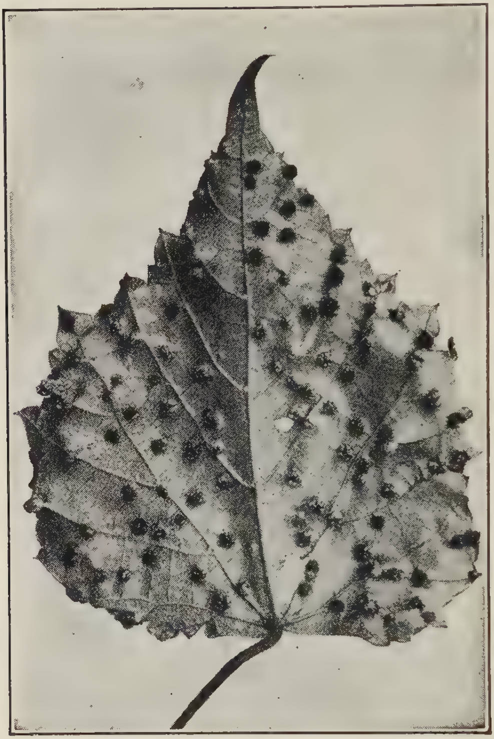


FIG. 110. The Phylloxera on wild grape foliage *U. S. D. A.*

Climbing cut worms are sometimes quite harmful to the buds and young shoots in California. They are usually controlled by the use of poison as bait, a small amount of which is placed at the base of each vine, or in the center of the head, on large vines. This poison may be made by mixing 25 pounds of bran, 25 pounds of middlings and 5 pounds of arsenic, applying dry. In other places a bait made of 40 pounds of bran, 2 gallons of molasses and 5 pounds of arsenic is used.

Other troubles. Chlorosis or Yellow Leaf is believed to be due to excess of lime in the soil. It occurs only in certain varieties, others are immune; the application of iron sulphate to the soil is reported as aiding in controlling it, but it does not always.

1. Winter Injury—Vines apt to be injured can be saved by laying down. A system of renewal from near the ground is

used. The canes are covered with earth, coarse manure, straw or cornstalks after the foliage falls.

2. Frosts—Late spring frosts may kill the growing buds. A second growth will be made, but the fruits borne on such are apt to be inferior. The frozen parts should be cut off at once. Grape foliage will withstand a temperature of 30° F. Fall frosts may destroy unripe grapes. Ripe grapes are not so easily hurt.

3. Sunscald—A hot sun may injure both foliage and fruit. A drooping system of training the vines, that covers and shades the fruit should be used where sunscald occurs.

4. Rain, cold weather and wind may so injure the pollen and the secretion on the stigmas that the pollination is weak and a poor stand of fruit follows. Rain may crack the ripe berries.

5. Birds may eat the ripening fruit. Bagging prevents this loss. It also protects the fruit from fungi and improves its quality. The bags are put on as soon as the fruit is set or when they are the size of small peas. One and one-half pound to two pound Manila bags are used (equipped with a clasp) or they may be pinned with a large pin.

6. Shelling or rattling seems to be an inherent weakness. There is no remedy.

Shipping troubles. California grapes are apt to be injured by Blue Mold, due to the long period during which they are held and the long haul. A certain amount is lost by crushing of the fruit due to improper packing, loading and bracing. Cracked, bruised or wormy berries, and those from dead stems are most apt to succumb to the mold. Shipments of California table grapes are, therefore, made in wooden drums and the fruit is protected by sawdust or redwood filler. In shipping, eastern grapes are apt to show the effects of some of the field diseases. Hard, red, brown or flesh brown berries which readily shell from the stem, and in wet seasons may be covered with a white mold, are due to downy mildew or red grape. Black rot is recognized by the shrivelled brown rotted berries, which readily leave the stem. These are bitter to taste and show the black fruiting fungus. Soft rot, the berries showing white or blue tufts of fungus on the cracked, bruised or wormy fruits and on the dead stems, is due to blue mold, pink rot, etc. Crushing the fruit in the basket is a fruitful cause of this trouble.

Harvesting. The grape is not ready to harvest until ripe. Large grape juice plants are particular about this. Usually the clusters are gathered by cutting with shears. The clusters are placed in trays which hold 25 to 35 pounds. They should be handled like eggs.

Storage. As soon as picked, if not to be shipped, the grapes should be put in cold storage or in common storage, so arranged that the temperature can be kept low, by opening at night and shutting in the day. If a temperature of 40° F. can be maintained, it is regarded as satisfactory. In such a house, it is possible to hold late harvested Concord grapes in fine condition until November. The Catawba, which is of excellent flavor, may be held until the last of March. Cold storage at a temperature of 30° F. is best if long keeping is desired. Grapes will keep four to six weeks longer if held at 30° F. than if held at 33° F., the temperature commonly used.

Packing. In the East when the grapes are sold for direct consumption, they are usually packed in Climax baskets, frequently called grape baskets. Four, 6 or 8 pounds are the usual sizes, depending on the market. Two, 4, 8 and 12 quart Climax baskets, one-half bushel and bushel baskets and grape trays are used in the East. Owing to the time of year at which the northern crop moves, October, the bulk of the crop or probably 90 per cent is moved in dry refrigerator cars under ventilation; grapes moving to the Southern states might be iced. The grapes shipped from the South are usually packed in 10-pound baskets for the northern markets and are shipped under ice in refrigerator cars. Later in the season, the crop is moved to southern markets. Delaware is moved in 5-pound baskets. The use of the Georgia peach carrier for grapes is not regarded with the same favor as the Climax basket.

Placing the fruit in the basket. The covers on Climax baskets are fastened by wire hooks. It is customary to leave the fruit a few hours before packing, removing all diseased, unripe or bruised berries. The stems are usually placed downward and out of sight, small bunches being used to fill the spaces between the large ones. The fruit is usually placed about one-half inch above the top of the basket, and should be level. When the cover is put on, it should not crush or break the grapes from the stem. The basket should be full enough so that the fruit will not shake in transit. It is customary in some mar-

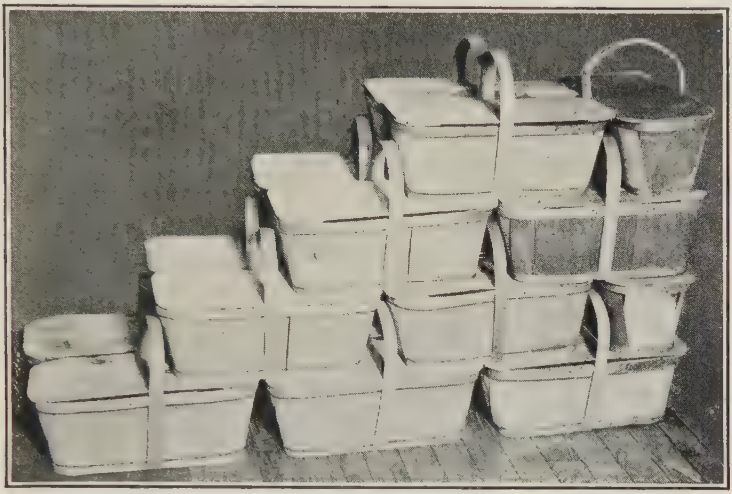


FIG. 111. Loading the car with climax baskets (a). The only place a basket should be placed crosswise of the car is next to the bulkhead to fill the otherwise vacant space. This shows good snug loading
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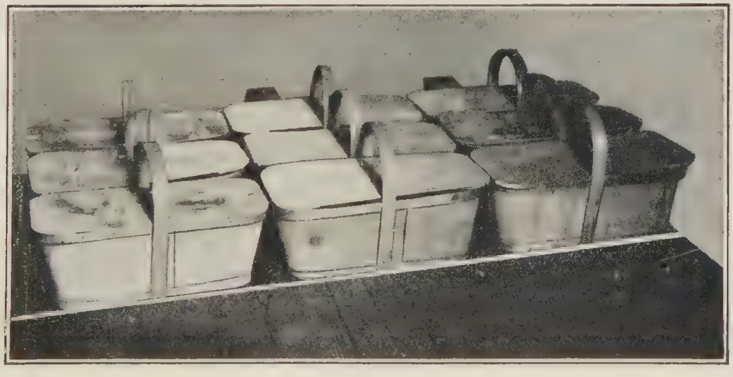


FIG. 112. Loading the car with climax baskets (b). There are four inches of space (note blocks) between the baskets and the wall of the car. There is one way to fill it. See FIG. 113
U. S. D. A.

kets to sell the fruit by weight. Usually, colored lithograph labels are placed on the cover or on the package, giving the name of the vineyard and name of the variety. It is needless to say that but one kind of grapes should be placed in a package, and that a reputation can be built up in this business the same as in any other.

Loading. For loading Climax baskets, especially the 12-quart size, the straight system is the only one to use. The first row of baskets is placed the full length of the car, from one ice bunker to the other, and the succeeding layers and rows are then placed in the same way with the baskets of each layer fitting between the handles of those below. The only place where baskets should be placed crosswise is to fill out the otherwise vacant space. No basket should be placed crosswise under any other condition. If it is found that the last row is too wide for one basket but not wide enough for two, the space is filled in by turning the baskets diagonally at an angle sufficiently great to take up all surplus space. In starting this diagonal row, it is necessary to "nose" the first basket into the corner of the car at one end and to repeat this operation on the other end of the second tier, so that the baskets cross and the handles act as braces. If care is taken to put each basket in tight so that it cannot move, the 12-quart baskets may be loaded five to seven high.

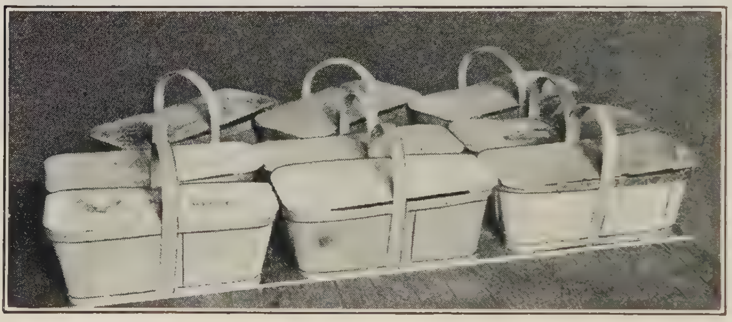


Fig. 113. Loading the car with climax baskets (c). The "diagonal" system for the last row takes up all the space between the row of baskets and the side of the car. A carefully loaded car, with the load stowed in this way cannot shift in transit

U. S. D. A.

The square system. In some districts, the baskets are loaded partly across in stacks. In nearly every case where the 12-quart baskets are loaded in this manner there is trouble, but it is not so objectionable when used with the 4-quart and especially the 2-quart sizes. The straight system of loading is recommended for even these. Four-quart baskets may be loaded twelve high and the 2-quart fifteen high. If there is a slack at one end of the car, a rack should be used to fill up the space.

Bulkheads. There is always danger from the open bulkhead in refrigerator cars. Where a space of 12 inches is left open on the bottom and there is no grating against which the baskets may be packed, it will be wise to nail on a strip 1½ inches in width to hold the baskets in place. This will be just as satisfactory as a 6-inch board, and will leave more of an opening for the circulation of air.

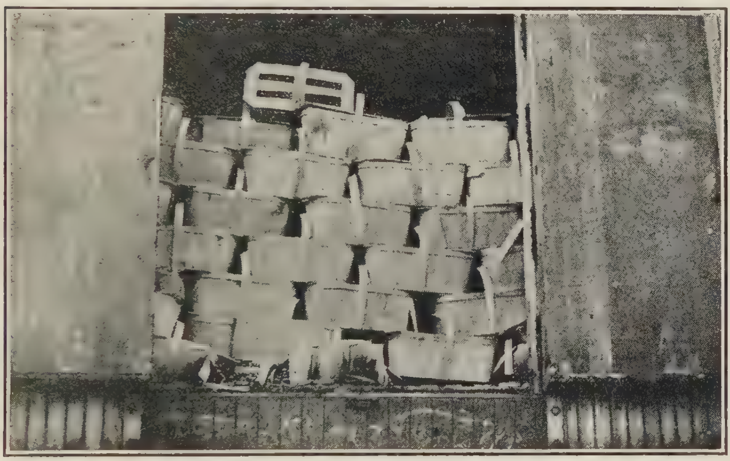


FIG. 114. Loading the car with climax baskets (d). Slack loading did this. The bottom baskets on the side toward which the shift came are crushed. In loading see that the floor space between the doors is level with the rest of the car and have all false floors running lengthwise of the car so that the load can slide on same

U. S. D. A.

Car floor. If all floor strips run longitudinally and the car floor is smooth and level, the baskets will slide on it when there is shunting, and there will be practically no damage. If the car floors are not level they should be made so, and the strips should run lengthways of the car.

Trays and boxes. Trays and boxes are used in shipping grapes. These should be placed lengthways of the car. If they do not fill the space completely, a brace should be put in at the end of the car or between the doors.

Mixed loads. If it is necessary to make mixed shipments of various packages, it is advisable to make complete rows of each kind of package, and these should be run from end to end of the car. They should not be mixed in any other way. The quantities of each type of package shipped should be such that the car may be loaded in this way.

Bearing capacity of a vine. A vine matures only so many clusters, depending a great deal upon the variety and the conditions under which it exists, but twenty to thirty buds well distributed over the vine on short canes or spurs is generally adequate. The average yield per vine is about 11.5 pounds. The average yield in New York is barely 8 pounds; in California it is 13.7 pounds. If an average of forty bunches, weighing one-quarter to one-third of a pound each be borne, 13 pounds would be made per plant. If the plants are 8x10 feet, 544 are grown to the acre with an average yield of almost 3½ tons. This is much above the average yield, but it is only half of some of the record yields. A good yield from a Concord vine is 12 to 15 pounds. Twenty pounds is a very good yield. Twenty-five pounds is a heavy crop for a mature vine. Four tons of Concord grapes per acre are considerably above the average. Grapes have sold as low as $10 a ton in bulk and up to $100, so that the income varies from practically nothing up to perhaps several hundred dollars per acre. This, of course, is for loose grapes in crates. When packed in baskets they sell for more.

Cost of production in New York. The average annual cost of production for the six-year period closing in 1921 of one vineyard in Western New York was $85 per acre. The average cost per ton was $30.80. The average yield for the period was 2.69 tons per acre per year, which is above the average for the district. The average selling price of the grapes from this vineyard was $76.32 per ton for the six years, which included the war period when prices were high. The average net profit was $38.90 per ton of grapes or $109.25 per acre for the vineyard. The costs and profits fluctuate widely from year to year.

Vinifera Grapes in the East. Vinifera grapes may be grown in the Eastern states for home use. and for a local high-class trade. The roots must be of some native grape and the vine must be given winter protection. In New York, the wild Riparia grape or *Vitis riparia* makes a good stock. *Riparia gloire* is one of the easiest secured varieties.

Grafting. Scions of two buds may be whip-grafted, either upon cuttings or upon rooted vines of the stock. This is done in winter and the plants are put away in sand or sawdust to callus. Young vines, however, may be planted and grafted the same spring just before they start to grow. This may be done near to the ground level, but not so close that the scion can take root. A whip or cleft graft is used and the earth may be mounded round the graft to the top bud to keep it moist. Six- or eight-year-old vines may be topworked by sawing them off near to the ground. A cleft may be sawed out or split with a chisel if the grain is straight; in this is inserted one or two cleft grafts. Mound with soil and let one or both scions grow as seems best and see that the scions do not send out roots.

In-arching. Grapes may be in-arched. A young vine of the Vinifera type is planted near a Riparia vine and at a certain height from the ground 2 or 3 inches of the surface of each vine is cut out to one-third of its depth and the cut surfaces are tied together with their cambium layers touching. The tops are checked by breaking the canes a little and when the union is completed the Vinifera grape is separated from its root and the top of the Riparia grape is removed.

Management of the vines. Vinifera grapes are often planted 6x6 feet in California, but 8x8 feet is advisable in the East. Two wires are used, the lower 28 inches to 30 inches and the upper 54 inches to 58 inches from the ground. Weak vines are pruned heavily but strong growers not so much. Usually four to eight buds are left to a cane.

Winter protection. The best method seems to be to remove the canes from the wires after pruning. While the ground is still workable in the fall, one man bends the cane down, taking care not to break the trunk, while two or three other men throw soil on it; 5 or 6 inches is enough. The trunk should be renewed from time to time, otherwise it gets too brittle.

Mode of training. The young shoots of Vinifera vines tend to grow erect. Hence, the canes and renewal spurs are tied to the lower wire and the new shoots grow upward to the second wire to which they attach themselves. When 4 to 6 inches above this they are pinched off and at the same time, if any axial shoots appear from between the leaves and the stem, these are rubbed off. This gives the fruit more light. The top buds of the cane will start into vigorous growth and when a foot or so high they may be cut back with a sickle.

Desirable varieties. Among desirable table varieties are Bakator, Lignan Blanc, Gray Pinot for early use, Chasselas Golden and Chasselas Rose. These are of fair quality and reasonably early. Muscat Hamburg is one of the most popular on account of its excellent quality. Chasselas Besson is also recommended. Gamay and Petite Syrah are black grapes. Rosaki, a yellowish green grape like the Malaga, may be used.

Some points worthy of emphasis are: (1) Ascertain whether the variety which it is desired to grow succeeds in the immediate location. (2) Ascertain which resistant stock is congenial to the variety. Frequently a variety will succeed for a few years only on certain stocks. The stock must be at home in the soil and the environment and at the same time be congenial to the scion. (3) The stock which is congenial to Vinifera varieties needs to be ascertained in each locality, for each variety. (4) The degree of cold which the Vinifera varieties will endure is still to be determined. (5) The cost of starting a commercial vineyard of Vinifera grapes will be fully double that of vines on their own roots. (6) It is to be expected that the disease troubles will be greater than those attending the production of native grapes.

CHAPTER XXXIX

THE GRAPE IN CALIFORNIA

The Mission grape, a vinifera, introduced in the middle of the eighteenth century, was for a long time the ideal grape for California. It was a good table grape, made good wine, and lent itself to primitive conditions. It is still grown as far south as Texas, but today the leading grape for wine is Zinfandel; for raisins, Muscat of Alexandria; for shipping, Flame Tokay, with fifty other varieties of more or less commercial importance.

Wine grapes. Bioletti states that among wine grapes, Zinfandel does best in Napa and Sonora Counties. Other widely grown red-wine grapes are Petite Syrah, Alicante Bouschet, Carignarre and Mataro, and in Southern California, the Blue Ebling. For dry red wine in the coast counties, he names Petite Syrah, Barbera, Belcan and Cabernet Sauvignon; for the hotter interior, Valdepenas, Lagrain and St. Macaire; for the sweet reds of Port type, Grenache, Alicante Bouschet, Tinta Madeira and Trousseau. For dry white wines, the chief varieties are Burger, Palomino, Feher Szagos and Green Hungarian; and the chief high quality varieties are Colombar, Semillon and the Rieslings—Johannesberg, Franken and Gray. These latter suit the coolest localities, while the first two are suited better to the warmer parts of the coast countries.

Raisin grapes. The Muscat Alexandria is the leading raisin grape. Practically all of the raisins in California are sun dried, although in some places the second crop of Muscats may be placed in artificial driers. Muscat grapes are gathered for raisin making when they show at least 24 degrees Balling, of sugar. The Balling test is now used for canned goods, and 24 degrees means in this case that the juice of the grape has the same concentration as a pure sugar solution of 24 per cent. The test is made by means of a hydrometer. Grapes which show 26 or 27 per cent, or riper grapes, make better raisins. Those showing 27 per cent Balling will give a 40 per cent greater yield of raisins than those showing 23 per cent Balling; hence there is every reason for allowing the grapes to become properly ripe before they are harvested. They are usually gathered on wooden trays which hold about 22 pounds of grapes, which dry to 5½ to 7 pounds of raisins. These trays are equipped with cleats on the top and bottom, which allow a space of 2½ or 3 inches between the trays when they are stacked.

Drying raisin grapes. For drying purposes, slight ridges are made in the soil on the ground, running east and west, with a V-shaped scraper. The trays are placed on these so that there is a slight tilt to the tray which exposes the grapes more directly to the rays of the sun. After drying for nine to twelve days, the grapes are turned by placing one tray on another and inverting them. In three or four more days they are dry. The length of time taken, however, will vary from ten to thirty days, depending upon the ripeness of the grapes and the temperature and moisture of the air. A temperature of 85 to 90° F. is regarded as the most favorable. If it goes above 100° F. flavor and appearance are injured, and the raisins are sold "loose" or as seeded raisins. If rain should fall while drying, injury may result, hence if there is any indication of rain the trays are collected and stacked one on top of the other. In some seasons, this may have to be done two or three times. Before the grapes are fully dry, the trays are stacked in piles of twelve to thirty and covered with an empty tray to permit the moisture in the fruits to equalize. They are then placed in sweat boxes, holding perhaps 90 pounds in the case of layers or 125 pounds or more of loose raisins. They are delivered to the packing-houses in these sweat boxes.

Bleaching. Light golden yellow Sultana raisins are bleached by dipping them in a solution of potash and lye of a strength of one pound to 12 gallons of water. This is kept at boiling point, the grapes being plunged into it for an instant and then into cold water. Some dip simply in boiling water. They are then passed through the sulphur box and spread to dry, taking care not to expose to the sun when too hot, which tends to darken the color. Only Sultanina and Sultana are cured in this way, although sometimes these are cured as outlined for Muscats, in which case they have a dark amber color. At the present time, there are four common classes of dried or raisin grapes, as follows:

1. **Muscat type of raisin.** Of these, California produces perhaps half of the world's supply. The varieties Muscat,

Gordo Blanco, Malaga, Feher Szagos and other varieties, are sometimes used when there is demand.

2. **Sultana.** They are made from the Sultanina or Thompson seedless grape; also from the Sultana, another seedless grape, the latter being grown largely in the Sacramento Valley and Sutter County in the Sacramento Valley. Both varieties require special care in pruning, for they do not bear satisfactory crops when short pruning is practiced. Generally, it is necessary to erect a trellis of Number 11 or 12 galvanized wire, stretched 18 to 36 inches from the surface of the soil. Four to six fruit canes are left per vine, about 4 feet to 6 feet long. These are tied to the wires. Care is taken to leave spurs consisting of two buds in addition to the canes, and it is from these spurs that the fruit canes of the succeeding year are secured. The fruiting canes must come in all cases from spurs of the previous year's growth and not from older wood. In other words, we have a system of pruning somewhat like that practiced for some of the native grapes of the East, with modifications.

3. **Currants.** These are made from the small, seedless black Corinth and White Corinth Grape, although the latter is not usually grown commercially in California.

4. **Dry grapes.** These are made of almost any kind.

Shipping California grapes. With the reduction in the demand for wine grapes at point of origin, there has developed a demand for home use. The shipment of grapes to eastern markets has increased. For table use the business has been developed on a relatively small number of varieties. The earliest shipments are made from Imperial County, beginning in June; from Fresno, Kern and Tulare in July and August. The leading early grapes are white, and are the Luglienga (which is usually shipped under the name "Madeline") and the Chasselas Dore (which is usually shipped under the name "Sweetwater"). In Imperial County, Persian No. 23 and Khalili, and in black grapes, Blue Portugese and Late Balino.

By July, the crop movement is more or less general, and the Flame Tokay comes into commercial use. The next important variety is Malaga, which is the principal variety of the Imperial Valley. The Emperor is a large, late, red grape, raised mainly in Tulare and Fresno, but more or less in several counties. The Cornichon is a long, late, black grape. The Black Prince is a moderately early round grape and is more or less generally grown. Verdal is a very late white grape grown in restricted areas in the Santa Cruz mountains. Black Morocco, Ferrera, Gros Colman and Pizutello are raised in considerable quantities. Both the Muscat of Alexandria and Sultanina are used as table grapes.

The grape season in California extends over at least six months, beginning with the earliest varieties in the Imperial and Coachella Valleys about June 1, and extending to the latest varieties which do not ripen until November 1 and may hang a month longer in a dry fall. Practically all table grapes are pruned in the goblet form, although the varieties Malaga, Emperor and Cornichon in very rich soils are pruned with long spurs and require much longer spurs than is possible under the goblet form of pruning.

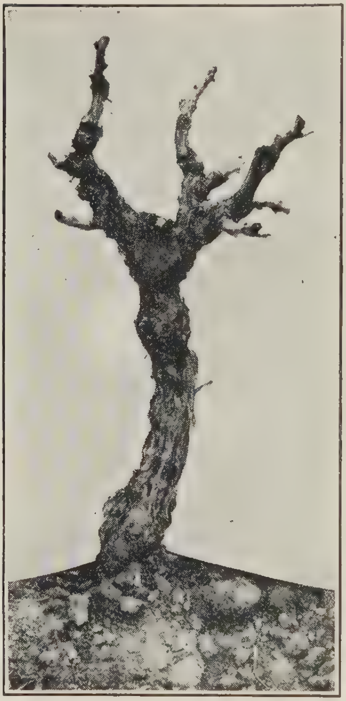


FIG. 115. Head Pruning system used in California for training certain varieties of grapes
Calif. Agr. Exp. Sta.

Pruning the grape in California (from Bioletti). Three systems of pruning are seen: Head, cane and cordon.

In head pruning the plant is grown like a small tree. The trunk varies from 1½ to 3½ feet tall. It is staked for four or six years, after which it maintains itself erect. On its top it bears four to eight "arms," 6 to 18 inches long, at the ends of which are left one or two fruit spurs of one, two or three buds in length of the previous year's growth. This is the most common system in California. It permits cultivation in both directions. The following varieties are grown in this way: Medium trunk—Muscat, Verdal, Palomino, Zinfandel, Alicante Bouschet, Duriff (Petite Syrah), Beclan, Grand Noir; high trunk—Tokay, Rose of Peru, Black Prince, Mission, Malaga.

In cane pruning the trunk is grown as before to a height of

2 to 3 feet. On the top it bears four arms, each 6 to 12 inches long, situated fan-shaped in the direction of a horizontal wire which supports the canes. A fruiting cane 2 to 5 feet long and bearing ten to twenty buds is left on the end of each arm; below each is a renewal spur of one or two buds which furnishes the cane for the next year. In weak vines fewer canes are grown. This system requires a wire trellis; usually Number 12 wire is used at about 30 or 40 inches from the ground which lifts the canes high enough to prevent the shading of the renewals; and another wire is stretched about 12 inches above the first to support the growing vines. This system is used almost always for Sultanina, Sultana, Black Corinth, Pierce, Concord, Isabella, Catawba and most Labrusca varieties.

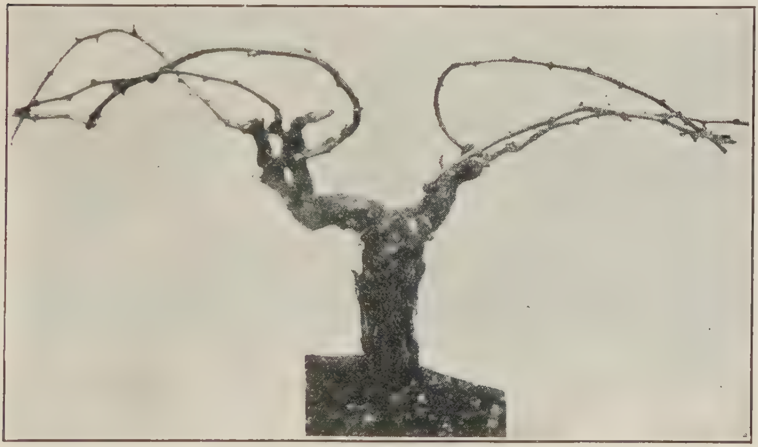


FIG. 116. Cane-pruning system for training certain varieties of grapes in California

Calif. Agr. Exp. Sta.

In cordon pruning a relatively long and slender trunk, often about 10 feet, is grown on a wire about 30 inches from the ground until it reaches the next vine. Upright arms 4 to 12 inches long are developed at intervals of 8 to 12 inches, and spurs are borne on these. This form of pruning is necessary for varieties which do not bear sufficiently on spurs, and is useful for most vigorous, large-fruited varieties of table grapes. It requires a permanent trellis and when established is regarded as an economical system to maintain. It is recommended for such varieties as Emperor, Ohanez, Cornichon, Molinera, Black

Monukka, Zabal Kanski and other vigorous, large-fruited table grapes, especially when growing in a fertile soil.

Handling the vines. Vines developed for the production of shipping grapes are usually grown high and the arms are given a wide spread, so that the bunches may develop, ripen and color more evenly and the fruit may be kept from the ground. Water sprouts and sterile shoots are pruned off soon after the grapes have set, thus concentrating the energies of the plant upon the shoots carrying fruit. The removal of the pruned canes should be made carefully so as not to damage the fruits. In some cases the fruits on the bunch are thinned a third as soon as they become well formed. This tends to increase size hasten maturity, promotes coloring and reduces excessive compactness of the bunch, because if a bunch is too compact it cannot be put in place without injury. The varieties Tokay and Black Morocco when grown in Northern California, are handled in this way. Thinning consists of removing the side branchlets, being careful to take them from that side of the bunch which is most compact. In some cases, a long, narrow-bladed knife or a pair of grape-trimming scissors is the most useful means of doing the work.

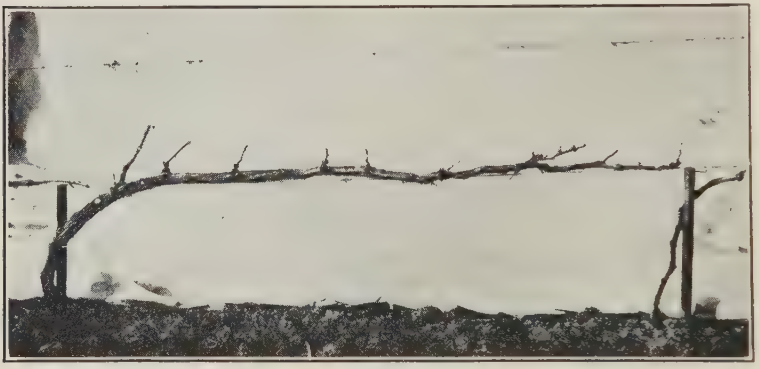


FIG. 117. Cordon pruning system of training grapes used for certain varieties in California

Calif. Agr. Exp. Sta.

Harvesting and packing. It is generally required that the fruits shall contain at least 17 to 19 per cent of sugar. Bunches are gathered with as little handling as possible, the bunch being held by the main stem. These are laid carefully in shallow wood boxes, in single layers, and hauled to packing-houses on spring wagons. They must be protected from dust and the direct rays of the sun. At present, they are usually shipped in chip square boxes which hold about 5 pounds of fruit. These are packed in open-sided crates which hold four baskets. Sometimes, the extra large bunches are packed in oblong baskets and but two are put into a crate. The Emperor grapes, since 1913, have been packed in lug boxes, protected by red-wood sawdust in much the same manner as the Almeria grapes are shipped from Spain. In the shipments from Spain, cork dust is used, which is unobtainable in America. Spruce and fir sawdust has also been used in California. The latter gives a flavor to the grapes, but this disappears after a few hours' exposure of the fruit to the air.

Currants or the Corinth grape. The dried currants of commerce are small grapes. These can be profitably grown in America, but the areas to which they are best suited are still a subject of investigation. Facilities for drying the fruit are of paramount importance, hence California may be expected to feature in their production. The outlook there is promising. Since this vine is subject to Phylloxera, it must be worked on some root resistant thereto, the same as other European grapes. In addition, it is important that the stock and scion be congenial. A number of *Vitis rupestris* hybrids are proving to be of value as stocks. The vines are usually planted 8x8 feet.

Girdling the Corinth vine. The vine must be girdled each year, either on the trunk of the vine or the arms while in bloom. This girdling must be thoroughly done and consists in making two parallel incisions in the bark of the grape and removing the bark between these cuts. If the vines are not on proper roots and are not properly girdled the crop is a failure. Girdling properly done doubles production.

Corinth grape fruit. The yield varies from 6 to 15 tons of fresh fruit per acre, or an average of 2 to 5 tons of dried currants per acre. Vines properly handled will produce from 18 to 45 pounds of fruit each. The fruit is seedless, rich in flavor, ripens early in the season and is very good for dessert. It must be protected from heavy dews while drying. Since it should not be dried in the sun's rays, the partial shade the trays get in the daytime protects them at night. The variety Panariti is regarded as the best. It carries fairly compact, long and narrow cylindrical or tapering bunches, shouldered, often in two parts. The berry is usually under one-quarter of an inch in diameter, purplish black with white bloom, smooth surface, skin thin, tender; flesh white, soft, juicy, seedless; flavor rich, very sweet. The fruit is high in sugar and is eaten fresh or dried; ripens July 15 to August 15. This variety often produces a small second crop of loose-clustered larger-seeded berries.

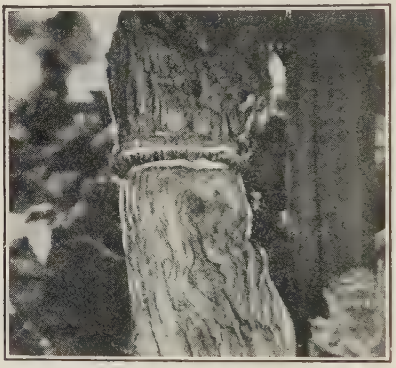


FIG. 118. Girdling the Corinth Grape. A ring of bark, one-half inch wide was removed while the vine was in bloom, two months later when the fruit was ripening the callus was formed and had partly closed the incision. The stock is Rupestris St. George. A congenial stock of American origin and girdling at the right time are essentials for success
Photo by U. S. D. A. Exp. Vineyard, Fresno, Calif.

PART IV

THE BRAMBLES

CHAPTER XL

THE BLACKBERRY

Blackberries (*Rubus spp.*) have all been developed comparatively recently from wild plants. While much progress has been made in improving this plant, much more can be done, and this is true of all the brambles. The grower of blackberries is wise who watches for variations and improvements among his plants and seedlings. Blackberries are grown in every state in the Union. The leading states are: Missouri, New Jersey, Illinois and California. The crop is really important in nineteen states, a remarkable showing for a plant which was wild seventy-five years ago.

Soil. The best soil is a strong loam or clay loam, retentive of moisture, well drained and preferably on a northern slope. Soils too rich in organic matter may produce vigorous and unproductive plants. Soils poorly supplied with moisture fail to mature good-sized fruits. Gravelly and sandy soils may get too hot. On flat, wet lands the plants are apt to suffer from heat and cold; a northern exposure is therefore often preferred.

Propagation. One-year-old plants, suckers or root cuttings are usually set. Certain varieties send up but few suckers, and hence these cannot be trusted to make an adequate supply of young plants; with certain other varieties too many suckers are produced. If fruit is desired, the suckers must be kept down, otherwise they drain the vitality out of the parent plant. Root cuttings offer the most certain way; it is also the most common one. Strong roots of vigorous, healthy young plants are dug and fed through a chopping machine, which cuts them into 2-inch lengths. These are usually planted in spring, in a well-prepared nursery bed, about 2 inches apart, 3 inches deep and covered. Better results are secured if the roots are dug in fall and cut and then packed in sand to callus. Growth will be more rapid in spring and a greater distance asunder may be given in the nursery row if desired, up to 10 inches. They are grown in the nursery for one year in the South and on the Pacific Coast, while in some other regions less favorable they are grown for two years and sold as yearling or two-year root cuttings. ((There is contention that the continued propagation of plants by means of root cuttings results in sterile or unproductive plants.)

Hardiness of varieties. Observations extending over several years at Geneva, New York (Agr. Exp. Station), show that many varieties of blackberries are not sufficiently hardy for northern conditions. A hardy blackberry is needed. The following lists are of suggestive value:

1. Hardy Varieties, or those not injured over 25 per cent during the winter: Agawam, Ancient Briton, Chautauqua. Eldorado, Fruitland, New Rochelle, Ohmer, Snyder, Stone Hardy, Taylor, Tyler and Wachusett.

2. Tender Varieties, some showing up to 90 per cent winter injury: Allen, Black Chief, Bow Cane, Child's Tree, Clark, Clifton, Dorchester, Early Harvest, Early King, Early Mammoth, Florence, Ida, Kittatinny, Lovett, Mersereau, Rathbun, Reyner, Success and Wilson Jr.

Time of maturity. Early varieties: Agawam (long season), Allen, Early Harvest, Early King, Eldorado, Minnewaski, Rathbun and Wilson Jr.

Late varieties: Agawam, Ancient Briton, Chautauqua, Child's Tree, Florence, Mersereau, Ohmer, Success, Taylor and Tyler.

Planting. Planting is usually done in spring, but may be done in fall, either in hills 7 or 8 feet apart each way, or in rows from 5 to 10 feet apart, with the plants 2 to 5 feet apart in the row. The hill system is very satisfactory. It enables working both ways, and lets the sun shine around each plant. The land is marked and furrowed and the plants set at the intersections. The plants are prepared by pruning broken roots and cutting off the tops 5 to 6 inches high. They are then put into a trough of water and hauled to the field. One man drops the plants in the field and two follow to plant. The plants are set an inch deeper than when in the nursery. They are tramped firm and the soil is worked around them.

Cultivation. In irrigated regions, water is applied as soon as planting is finished; in others, "horse leg" irrigation is used. Constant tillage must be maintained. Care should be taken not to disturb the plants while in full bloom. The plants need all the moisture there is in the soil. Cultivation must be shallow at all times. Deep tillage cuts the roots and stimulates the formation of suckers which must be treated as weeds. The value of thorough tillage is brought out in the table below:

Tillage of Blackberries in Western New York (Wilson)

Treatment	Farms	Acres	Yield per acre quarts	Income per acre
Intensive cultivation	9	14.65	1890	244.65
Plowing plus cultivation	8	14.83	1766	153.46
Moderate cultivation	5	2.58	1032	92.45

Fertilizers. The plants may be fertilized but an excessive amount of stable manure is not advised. The soil can be well enriched with fertilizers, containing phosphoric acid and potash. On the lighter soils nitrate of soda is beneficial after the plants have blossomed. Heavy applications of manures are not made until the patch has started to bear. Care must be taken not to overfeed the plants and form new canes which will not mature. The plants may be mulched. The sowing of a cover crop about the time the berries are ready to be harvested is often practiced, cultivation having been maintained to this time. Crimson clover is a very satisfactory cover crop where it does well. Results secured in New York are shown in the table below:

Manure and Fertilizers on Blackberries in Western New York (Wilson)

	Farms		Acres		Yield quarts per acre		Income per acre	
Treatment	1909	1910	1909	1910	1909	1910	1909	1910
Manure or Fertilizer used	7	9	12.11	22.15	3,350	1910	$233.99	$219.44
No manure nor Fertilizer used . .	5	11	4.91	10.41	2,379	1684	170.69	136.74

The above figures are of suggestive value and would indicate that one might try an application of manure or fertilizer if same is not being used, to determine whether it would pay.

Training and pruning. Varieties vary markedly in their habit of growth. Some like Taylor and Ancient Briton are representatives of the "long cluster" group and were developed from plants which grew tall and upright. Therefore, before pruning, we must know the plant. The canes of this class are strong, purplish and carry straight prickles; the fruits are borne in long clusters, are thimble-shaped, sweet, and carry many small, closely packed drupelets. The Agawam, Kittatinny, Lawton and Snyder are members of the "short cluster" group. They are smaller and weaker plants than the long cluster group, and carry few or no prickles. The berries have few large, irregularly set drupelets.

Early Harvest came from a plant which was low and bushy. The Early Wilson and Wilson Jr. have a low-spreading habit of growth and come from another parentage. The Topsy or tree Blackberry came from the Sand Blackberry, a sturdy little shrub. The mass of varieties now grown may be divided into upright growers and trailing vines like dewberries.

Pruning. Some vines must be encouraged to grow up, others need to be kept down. The custom in the East the first year is to let the canes reach a height of 18 to 30 inches, and then cut them back a few inches to make them grow low, upright and stocky, so that a trellis will not be needed. The aim in pruning is: (a) to keep the tops cut back to a proper height; (b) to keep the plant stocky; (c) to keep the plant in the best possible condition to mature first-class fruit, and (d) to remove the old canes. In cold climates, pruning is done in autumn. The canes are laid down and covered with soil to protect them. This is permissible for a home-use patch, but its value commercially is in dispute.

Pruning old canes. In pruning, old canes can be removed as soon as through fruiting, for the fruit is all borne on one-year-old wood. Over much of the country, the young canes are tipped or pinched when 18 to 36 inches tall. This tipping must not be delayed. One may need to go over the patch three or four times to do it. It induces branching and develops a stocky bush. If allowed to grow tall, making it necessary to cut back to 2 feet, a poor, weak bush and a poor crop result.

Spring pruning. Allow a strong cane to every 10 or 12 inches of row. Five canes are ample for a plant. In the spring, the laterals are cut back to 18 inches or so, depending on the amount of buds set. This is really in the nature of thinning. With some varieties it should not be done, the fruit buds being located near the ends of the laterals. One should study the variety before outlining the policy. Lack of knowledge probably explains the results secured in Western New York and shown in the table below:

PRUNING OF BLACKBERRIES IN WESTERN NEW YORK (WILSON)

Treatment	Farms	Acres	Yields per acre quarts	Income per acre
Summer pruning only	13	18.33	2,028	$222.28
Summer pruning and spring pruning	8	14.73	1,733	144.96

Staking the plants. In the West, when planted in hills, two stakes are sometimes used 15 inches apart, one for the old canes, the other for the new. This aids in picking. The stakes are 4 to 6 feet high.

Training on a trellis. When a trellis is used, two No. 10 wires are fastened on posts 4 to 5 feet high. One is placed at the top, the other 2 feet lower; better still, an 18-inch cross arm may be nailed on each post at the top and at 3 feet from the ground; the wires are nailed at the ends of these. Still another development is to use a 4-wire trellis for the sprawling vine type, the two lower wires being on cross arms; the new canes are trained on the upper wires to get them out of the way for harvest; when pruned ready for fruiting, they are dropped onto the two lower cross-arm wires.

Method for Central states. In the Central states, where moisture is apt to be deficient, the canes are often left unpruned in the summer. These are cut back to 3 feet tall in spring. In this way all the fruit is set that can be matured. In some sections, the pruned bushes are covered with straw to protect them against late spring frosts.

Winter injury. Winter injury is the most serious obstacle in commercial blackberry growing. A plant may endure a low temperature one winter and be destroyed the next by cold not nearly so severe. Humidity as well as temperature seems to be a factor. Five degrees below zero has destroyed plants in Kansas and Nebraska and 14 degrees below zero has not hurt them in New York. Winter protection is believed by some to be profitable, even in Pennsylvania. The laying down of plants is accomplished by loosening the soil on the sides of the plant, bending its tops over and covering with soil; the new plant is bent with its tips near the root of the first. In some cases, this is adequate; in others the whole plant is covered. The remedy is to develop varieties not so apt to winter kill.

Insects and diseases. Borers do considerable damage but may be kept in control by cutting out and removing the infested canes. The Tree Cricket (See Apple) is injurious. Crown-galls are often seen on plants, and some growers advise that they are not dangerous and that it is not worth while to try to control them. Orange Rust and Anthracnose are two troublesome fungus diseases. Both are usually kept in control by the removal of affected plants and by good tillage. In some sections, spraying

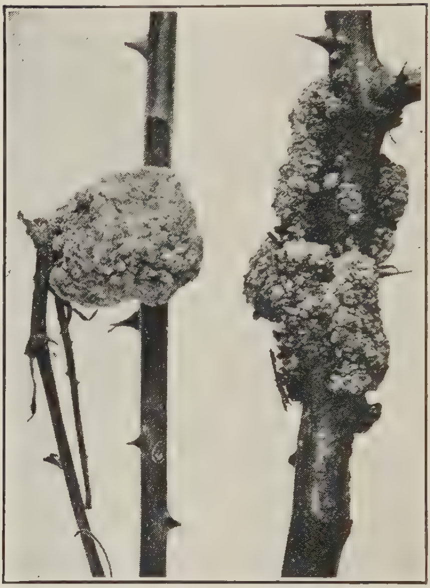


FIG. 119. Crown-gall disease on blackberry canes
Corn. Univ. Agr. Exp. Sta.

with bordeaux mixture for Anthracnose seems to be worth while. Thus in Washington two applications are made, as follows:

1. Just before the buds open, spray with bordeaux mixture 5:5:50 to which has been added 1 pound of resin-fish-oil soap to each 50 gallons. The resin increases the adhesive power of the bordeaux, the soap kills leaf-hoppers.

2. Two to three weeks after the blossoms fall use a soap and Burgundy mixture—2 pounds copper sulphate, 3 pounds washing soda, 100 gallons water, 2 pounds soap. Add the soap solution when ready to apply and agitate well. The Burgundy mixture does not stain the fruit.

Picking. Blackberries are not ripe as soon as they are black, but for long distance shipment they must be picked early. For home use they should remain until ripe and fit to eat. With refrigerator cars and precooling of the shipments, the fruit can now be more nearly ripe when picked than formerly. The fruit is usually sold in the quart box and this is filled as picked. The fruit should be covered as soon as picked. A bitter taste develops on exposure to the sun.

Yields. The average yield for the country is about 1,130 quarts per acre. The highest average yields are reported from the Pacific states, the average of all being 2,660 quarts or 230 per cent above the average of the country. Yields of over 6,000 quarts per acre are reported. The average yield of thirteen farms in Western New York in 1909 was 3,132 quarts per acre, the income per acre being $222. In 1910 the average yield per acre on thirty farms was 1,490 quarts, the average income per acre being $135 or 8.87 cents per quart, prices varying from 6 to 12 cents per quart. Bailey gives the range of yield as 1,600 to 3,200 quarts per acre.

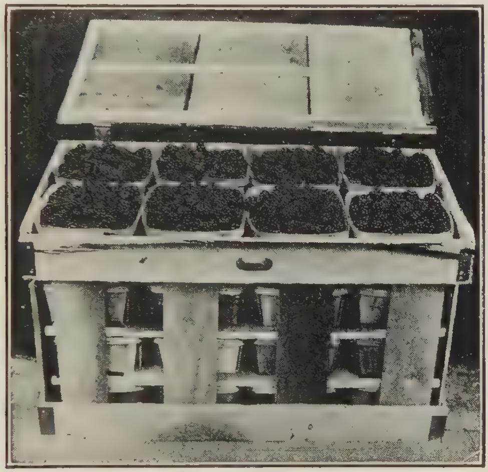


FIG. 120. Blackberries in a 32 quart shipping crate

The *North Western Horticulturist* reports that in the Puyallup Valley in pre-war days, it cost 25 cents or 30 per cent of the receipts to pick a 24-quart crate of blackberries. The crate cost 15 cents or 17.6 per cent; hauling to the depot and incidentals, 7½ cents or 8.8 per cent; the association's charge 5 cents or nearly 6 per cent, making a total of 60 cents. The Evergreen Blackberries netted the grower on an average 85 cents per crate, leaving 25 cents per crate or 1 cent a quart or 30 per cent of the total for refunding the capital expended in planting and bringing the patch into bearing and to cover labor income, rent, interest, taxes, sundry charges and profit.

CHAPTER XLI

THE DEWBERRY

The Dewberry (*Rubus spp.*) is a trailing blackberry, but is perhaps a little less hardy. It is distinguished from the blackberry by its low trailing habit of growth, the few flowers which appear in the cluster and by its habit of rooting from the tips instead of suckers. The dewberry is an American fruit.

Types of dewberries. There are several types: The Lucretia dewberry is an example of the northern type. The Bartel, another hardy variety, has done well in Wisconsin and is from a native plant. The Manatee and similar types are derived from the southern dewberries. The Skagit Chief, along with others, represent the western dewberry. Lucretia and Bartel are the chief varieties. Mayes and McDonald are grown in the western states, but the latter does well in the East. Lucretia will pollenize McDonald.

Propagation. Plants are propagated from tips and from root cuttings. When tips are used a shallow furrow is plowed and the tips are laid in and the furrow turned back again over the tips. The tips must be covered. This is done before harvest. The plants are ready for use next spring. Root cuttings may be made by storing cuttings of the size of a lead pencil in sand over winter and planting out next spring. This method is not so successful as with the blackberry. They should be planted in rich, moist soil, 3 inches deep. An old bed may be plowed up in spring and well worked and then the new plants allowed to grow that summer, from the cut roots.

Soil and planting. The soil usually deemed best is a sandy loam, but good, deep loams will suit. Planting is usually done in spring, but can be done in fall. The distance apart will depend upon the variety and the mode of training. If allowed to grow prostrate, the plants are put in hills 5x5 feet; if on a trellis 6x3 feet or 7x4 feet. In planting, the land is cross-marked and furrowed one way. The plants are dropped in the furrow at the cross-mark, covered with the foot and the furrow is returned. They are then tramped firm and straightened up and cultivated; in irrigated sections, the water is turned on. As with all brambles, the top is removed before planting.

Pollination. It is advised that more than one variety be included in the patch in order to secure cross-pollination. The varieties may be planted in strips of a few rows wide.

Culture. The bed will stand regular feeding. Stable manure may be applied in winter or early spring before uncovering the plants if they are laid down. Giving constant cultivation up to harvest time and for a while after, is advised. The culture of the dewberry is much the same as the blackberry, except in the manner of training.

Training. The blackberry is an upright grower and can support itself. The dewberry is a trailing vine and is usually trained on a trellis, or the vines of each plant are tied to a single stake. In some sections of the West they are allowed to grow prostrate. Where a trellis is used, it consists of two wires, the top wire being 3 feet from the ground. The fruiting canes are tied to the stake or trellis in the spring, being shortened in to 3 to 5 feet long. The young canes are allowed to trail on the ground, in the direction of the line of cultivation. They are out of the pickers' way. Where the plant needs protection the canes on the ground already are easily covered. The old canes are cut out after fruiting and the new ones are tied up the following spring.

Without a trellis. In the Western states, they are grown without a trellis and are cultivated both ways. A pruning is given as soon as the new canes are 12 to 18 inches tall. They stand up at this stage and their tops are cut off with a sickle. This pruning must be done on time. It forces out laterals and stiffens the canes. A second pruning is given just before picking begins to get the new wood out of the way of the pickers. All laterals developed are cut back to 2 to 2½ feet long. This is a detrimental pruning; it starts considerable new growth, and if done too late the new wood fails to mature. This should be avoided if possible. A third pruning is usually left until the following spring and consists of removing the old canes and shortening such new ones as are too long. Sometimes this is done in fall. Where irrigation is practiced the land is well watered in spring and kept moist. During harvest, water is supplied after each picking to swell the fruits and prevent drying on the cane. Water is withheld at the close of the picking season in order that the wood will ripen better.

Insects and diseases. These are similar to other brambles. Double Blossom is due to a fusarium disease, which causes the blossoms to appear as doubles. The ovaries are sterile, but the fungus matures its spores in them and these escape and drop on the young buds, forming on the new wood to repeat the process next year. Hand picking the affected buds is advised.

Picking. A picker will harvest five to seven crates a day. Eight to ten pickers are required to an acre. The canes are gone over twice a week. The pickers use a glove on one hand to pick up the canes and one with the finger-tips removed on the other hand. Some use the 12-basket carrier to pick in; others use the 24-basket shipping crate. The deck boards are carried along so that not over 12 baskets are exposed to the sun at any time. In some cases a cloth is tacked on in the center of the crate to cover either half while the other is being filled. A wire bale clamped on the carrier is used as a handle. The fruit is graded as picked. The pickers are paid for culls as well as good fruit.

Time to pick. The fruit is ready when it is a glossy black. When over-ripe, it turns dull and gray. All-green, over-ripe and defective fruit are put in the cull box. Ripe berries soon mold. The fruit is very soft. It will not ship far and must be on the market in thirty-six hours after picking. It should not be picked when the dew is on, nor when the fruit is damp. The fruits ripen ahead of blackberries and on account of their fine flavor are rapidly gaining in popularity.

Yield and costs. A good yield is 200 to 275 bushels per acre. The 24-quart crates cost 27 cents, the picking 35 cents, oversight and crating 5 to 10 cents. They sold as high as $2.25 per crate f.o.b. loading station in pre-war years.

CHAPTER XLII

THE LOGANBERRY

The Loganberry (*Rubus vitifolius*) is a red dewberry, native of the Pacific Coast. It has the shape of the dewberry and the red color of the raspberry. The plants are strong, vigorous growers and productive, and find favor with growers on the Pacific Coast and in some other sections of the country, and in England. In the Northeastern states they are not particularly hardy. A winter temperature of zero seems to limit their production.

Soil. On the Pacific Coast where this fruit receives the most attention, the soil most esteemed is a deep, rich, dark loam, one well supplied with moisture but not wet nor with a leachy gravel sub-soil. Thorough drainage is important, for the plant will not live with standing water around it. If there is not natural drainage, tile drainage is essential. The rows should run north and south; a 16-foot cross road every 400 feet is desirable, since the pickers do not then have to carry the fruit too far.

Selecting plants. Good plants are essential. Tip plants are usually preferred, that is, the tip of the cane has been put down and allowed to root, during the fall of the previous year. Sometimes these plants are dug up and transplanted into a nursery row and grown another year when they are sold as transplants. Taking the tip plant saves money and the transplants are sometimes grown in crowded rows. When plants are shipped a distance many growers prefer the transplants. Care should be taken in packing them that they do not heat.

Planting. The land should be fall plowed 10 to 12 inches deep. In the spring a cross plowing is sometimes given 6 inches deep. The land is then fitted and put into excellent condition. The rows are marked out 8 feet apart each way. A hole is dug where the rows intersect. Six men will plant six acres a day, one doing the digging, five the setting. The custom is to spread out the roots, draw some soil over them, tramp it firmly and cultivate the rows immediately, both ways. No crop should be grown between the rows. About August 1 the plants start to grow and by October 1 the vines may be 20 to 30 feet long. As the vines lengthen they are laid in one direction and cultivation is run that way. The plants are now ready for the wires. These are erected as for grapes. Seven-foot cedar posts are set 2 feet in the ground every 32 feet. Three Number 12 wires are used, one on top of the posts, the others 20 inches apart below. Good anchor posts must be set at the end of each row.

Management of the patch. The canes are put on the wires by October; the long ones are wound around the wire, the short ones tied to them. The wires are covered with canes but it is not wise to bunch the canes together. New plants can be secured by turning the tips down to the ground and covering them 3 inches deep with soil in October. These will root that fall and may be moved next spring. Fall plowing is practiced, two very shallow furrows being thrown toward the vines with a one-horse plow. Other furrows further away are made deeper with a two-horse plow. A deep dead furrow is left to move surface water in the winter. In spring, the plowing is reversed, being away from the vines. A grape hoe and hand hoe are used close to the plants to remove the weeds. Constant cultivation is given until July.

Harvesting. Harvesting begins soon after the middle of June and may last over six weeks. If the fruit is to be shipped fresh it must be firm when picked. If it is to be dried it must be left until fully ripe, for then it dries heavier and makes a better quality product.

Pruning. As soon as harvesting is over the old canes are cut off at the ground and the new ones are trained on the wires. The old vines are cut up by disk harrows and the land is plowed toward the canes in September. If done early and economically the cutting of the old canes and training of the new can be done in sixty hours per acre by one man. If left until later more time is required.

Shipping. When shipped fresh the fruits are put up in 24-quart crates. They are not faced. The fruit is sold fresh, canned, dried. The juice is sold also.

CHAPTER XLIII

THE RASPBERRY

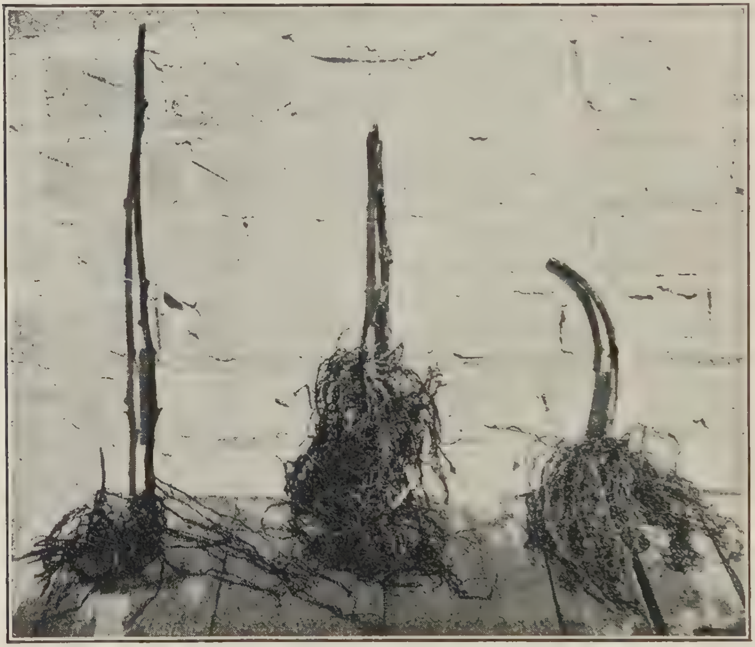
This splendid fruit may be divided into three classes: the Red Raspberry (*Rubus strigosus* and others), the Purple Raspberry (*Rubus neglectus* and others), and the Black Raspberry (*Rubus occidentalis*). Several species are in cultivation. An interest is taken in these fruits in every state of the Union and even in parts of Alaska. Production is chiefly centered in the East and West, North-Central and Middle-Atlantic states, with New York leading with nearly a quarter of the entire acreage of the country, followed by Michigan, Ohio and Pennsylvania. The Pacific Coast states show a decided gain in these crops. The Puyallup Valley region of Washington, 14 miles long, ships fresh fruit as far east as Pittsburgh.

Soil. The black raspberry requires deep and moist soils. The general opinion is that the red raspberries do best on the lighter loams and the blacks on the heavier loams. The question is open for investigation. Red raspberries are more hardy than blacks and are grown very well in Canada, as far north as the Yukon. The plants thrive best on virgin soils, rich in humus. The land may be fall-plowed and the plants set in the spring. The land should be well fitted and free from weeds. If the land is in good heart, manure or fertilizers may not be needed since it is undesirable to stimulate too much growth or cause the plants to grow too late in the fall and thus be winter-killed. The influence of soil on yield of raspberries on various soils in western New York as reported by Wilson of Cornell University is shown in the table below:

Red Raspberries	Number of acres	Number of farms	Yield per acre (quarts)	Income per acre
Gravelly loam	63.5	40	1,414	$141.43
Sandy loam	30.6	21	1,306	147.29
Clay loam	7.4	7	2,097	237.04
Black Raspberries				
Sandy Loam	77.85		1,434	106.59
Gravelly loam	51.08		1,405	107.05
Clay soils	10.25		1,266	100.83

Clay loams are not usually considered suitable for raspberries unless they possess a shaly subsoil. The general opinion of the growers may be seen from the acreage on the various soil types.

Planting. Planting may be done in fall or spring. It is usually best to plant the black raspberries in the spring. Those planted in fall should have a furrow thrown to them on each side to afford winter protection. Spring planting should be accomplished as early as can be done. The planting of growing suckers of red raspberries may be delayed until they are in leaf. To plant growing suckers, select a dull, wet day in summer and dig up the plants when 4 to 8 inches tall, and transplant at once.



Ranere (red) Columbian (purple) Cumberland (black)

FIG. 121. Showing good raspberry plants

U. S. D. A.

Marked differences in growth are seen from planting strong, vigorous, well-rooted suckers and feeble and weakly rooted plants. Those having no well-developed root system will make only half the growth of best plants. It often pays to throw 50 per cent of the plants away. The dormant tops are cut back to within a short distance of the root.

Setting out the plants. Red and purple raspberries are usually set in rows 6 or 7 feet wide, with plants 2 to 3 feet in the row, depending somewhat on the soil and the variety. In the red raspberries, the suckers formed may soon fill the row unless prevented. The plants may also be set in hills 6 or 7 feet apart by 4 to 6 feet, or they may be set 5 feet by 5 feet and cultivated each way. The black raspberry requires more space—the rows 7 to 9 feet apart and the plants $3\frac{1}{2}$ feet in the row. If planted in hills the check rows may run 5 feet by 6 feet. The hill system may produce the finer fruit, but the row system is most generally in use commercially. Suckers and root-cuttings may be planted a little deeper than they grew. Tip-layers should not be set so deep, or if the hole is deep, should not be covered too heavily. The soil should be compacted around the plant, but care should be taken not to injure any of the young buds on the crown.

DISTANCES USED FOR PLANTING PURPLE RASPBERRIES IN WESTERN NEW YORK (WILSON)

Distance apart	Number of farms	Number of acres	Yield per acre (quarts)
6 feet x 5 feet	8	24	1,667
7 feet x 3 feet	11	65	1,739
8 feet x 3 feet	4	10	1,709
7 feet x 4 feet	4	12	2,324

Here is shown a variation of from 21 to 30 square feet per plant, with the latter the least productive. It does not follow that these growers were not wise in giving the greater space to the plant, for it may have been that their soil conditions were such that this was the maximum number of plants it would carry, and the planting, 7 feet by 4 feet, may have been on land well supplied with moisture. Too many factors are unknown to use the above table as anything more than suggestive.

Propagation. Red raspberries are usually secured by digging up the suckers from the parent plants formed in the bed. It is desirable that a piece of the horizontal and fibrous root accompany each plant. Black raspberries are usually propagated by means of tip-layers. The tip of the cane is bent down to the ground in mid-August and covered with 2 or 3 inches of soil. When these root, they are taken up and planted. Tips taken from two- or three-year-old plants are best, because they have more vigor and are less subject to disease. Usually about 6 inches of the tip of the cane is left on the young plant when dug. This serves as a handle for tying when bunched. Purple raspberries are hybrids between the red and the black. They may be propagated by means of tip-layers.

Variety to plant. There are only a few commercial varieties as yet. Those doing well in the region should be used. New varieties should first be tried out. A considerable amount of work is being done in the development of new varieties and considerable progress is being made in the breeding of strong, vigorous, productive varieties.

Pollination. All varieties are regarded as self-fertile, so that the problem of pollination is not considered to be a factor.

Cultivation. As soon as planted, cultivation begins and usually is maintained in both directions until harvest to conserve moisture and keep the land clean. The first year, a hoed crop may be grown between the rows and the berry plants hand-hoed if necessary. The tillage should be shallow at all times. If the roots are cut the formation of suckers is encouraged which is a drain on the parent plant. The cultivator rather than the plow is to be preferred for small fruits, but on some soils the use of the plow is essential.

Cover crops. In the Eastern states, it is customary to sow a cover crop of 10 to 15 pounds of red clover, or a bushel of oats and barley per acre. Any other crop also may be used. These are sown between the rows only, where they are easily destroyed. Frequently the land is fall-plowed, shallow, toward the canes, and in the spring replowed, throwing the soil from them. Stable manure may be applied if available; if not, a mixed fertilizer fairly high in nitrogen is probably best if the plants need fertilizer. Nitrate of soda, 200 to 300 pounds per acre, is sometimes used as soon as the berries are set. Tankage is very satisfactory at times.

Pruning. With all brambles, canes that have fruited should be removed as soon as the crop is harvested. Surplus canes may be removed in the following spring. The red raspberry canes are not summer-pruned. Four to six canes per plant are desired, an average of about one plant per foot. In the spring these are shortened-in to 3 to 5 feet tall, depending on their vigor. The poorer the soil and the less adequate the tillage, the fewer the number of canes that should be left.

Black raspberries require more pruning than the reds. Four canes are usually left on a plant. The succulent tips are pinched back when they reach the height of 2 to 3 feet. This involves going over the patch two or three times to get all the plants. In spring, the laterals which have developed are shortened back from one-third to one-half of their growth, as described for blackberries. Severe heading back of the laterals reduces the number of fruits set without diminishing the yield, since the fruit sizes larger. When grown in hills the spring cutting back is often omitted. The second year the plants bear a small crop and the third year a full crop may be looked for. Purple raspberries are usually handled as outlined for black raspberries.

Hardiness. Red raspberries are usually more hardy than the black raspberries. If the plants are laid down the canes should be bent so that they tend to shield the crowns as described for dewberries. Winter injury may be due to low temperatures but this is not so important as impaired vigor due to lack of good foliage the previous summer, to overstimulation of wood growth, or too rapid growth of wood which failed to mature.

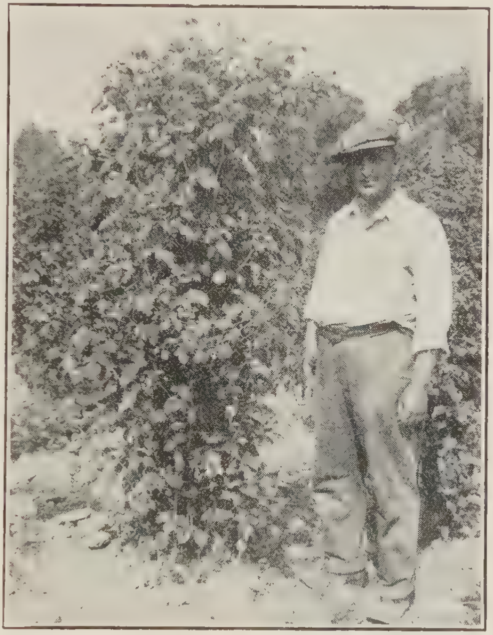


FIG. 122. Red Raspberry—fruiting plant showing hill method in use at Milton, N. Y. Seven canes were left and tied to a stake. The land is cultivated in both directions

Courtesy U. S. D. A.

Insects. **The Tree-cricket** (*Œcanthus nigricornis*) lays its eggs in punctures made in the canes. Often 2 inches of injured surface are seen with the result that the part of the cane above this dies or is weakened so that it fails to grow properly. The gathering and burning of the infested canes while the eggs are in them is advised. This cricket also attacks blackberries.

The American Raspberry Beetle (*Byturus unicolor*) usually appears in May and feeds upon the buds and tender leaves. It also attacks the blossoms. Spraying with arsenate of lead, 3 pounds paste to 50 gallons of water, as soon as the insects commence work is advised.

The Raspberry Cane-Borer (*Oberea bimaculata*) lays its eggs in the young shoots about 6 inches from the tip of the cane. It then girdles the cane above and below the eggs causing the cane tip to wither. The egg hatches and the borer lives in the cane that season, and in the following season reaches the base. Cutting out of all canes as soon as fruiting is over and all young canes showing the injury is advised.

Raspberry Sawfly (*Monophadnus rubi*). The larvæ eat the foliage of all brambles. Spray with arsenicals. Hellebore may be used if the fruit is maturing—one ounce to one gallon of water.

The Red-Spider (*Tetranychus bimaculatus*). In dry weather these mites damage the crop. Use nicotine sulphate, three-fourths of a pint to 100 gallons of water. Dusting with nicotine or sulphur may control the red spider if the temperature is 80° F. or higher, but control is generally difficult.

Diseases. Anthracnose (*Glœosporium venetum*). Black raspberries are most seriously affected, red raspberries the least. Gray or brownish spots or patches develop on the plants, noticeably on the canes. Sprayings with bordeaux mixture 4:4:50 with a sticker of molasses, 1 gallon to 50, beginning when the plants are 6 to 8 inches tall may aid, but it is doubtful whether it will pay. Another sticker sometimes used is resin and fish-oil soap—2 pounds dissolved in 2 gallons of water for each 50 gallons of spray. The better plan is to make new plantations at frequent intervals on new land. This is especially important with purple and black caps on soils which are naturally rather poor. In some cases but two crops are taken, and the new canes made the year the second crop is secured, are cut down as fast as made. New plants being secured from the first crop. Give plenty of room for sunlight and air; remove old wood as soon as harvest is over; give care to the patch in its early life and secure

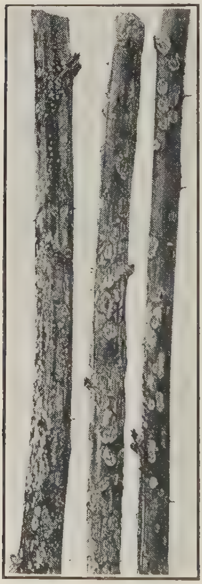


FIG. 123. Anthracnose on canes of black raspberry *Cornell Univ. Agr. Exp. Sta.*

the best returns possible in its early years. Be sure the plants set are free from disease.

Orange-Rust (*Gymnoconia interstitialis*). This disease sometimes sweeps away plantations of black raspberries. It also attacks blackberries, but seldom red raspberries. The orange red rust on the under-surface of the leaves is evidence of the disease. A plant once affected never recovers. Dig it up and burn it.

Cane-Blight (*Leptosphaeria coniothyrium*) attacks all raspberries, but does most injury to the black caps. The leaves wilt and the canes die as they near maturity. The removal and burning of diseased canes and those which have fruited, as given under anthracnose, is advised.

Mosaic, Yellows. The plants get stunted, the foliage yellowish, the fruit small and dry and worthless. The yellowish leaves, the stunted plant may indicate what is known as Mosaic. The only treatment is to eliminate such plants. Make new plantings from beds free from this trouble.

Crown-Gall or Root Knot (*Bacterium tumefaciens*). Red raspberries are most commonly affected. Swellings or knots occur on the roots or near the ground level. The disease spreads from raspberries to peaches. The infection remains in the land for years. Apparently healthy plants from a diseased patch may have the disease and transfer it.

Blue-Stem (*Acrostalagmus caulophagus*) is found in the Pacific Northwest. The name identifies the disease in many cases. The disease may be serious. No remedies are suggested. Blue-Stem or Wilt seen in New York on black raspberries is probably caused by the fungus *Verticillium albo-atrum*. Selection of resistant plants is advised.

Shipping troubles. Decay in transit is the big problem of berry growers. It is usually due to the development of molds, which include the Gray or Black Mold (See Strawberries) and the Blue Mold (*Penicillium*) (See Orange). These do not attack firm, sound berries. They cause the decay of those injured or bruised in handling, or soft from being overripe. The degree of maturity of the fruit when harvested, the care used in handling it and the promptness with which it is precooled determine the distance to which the fruit may be shipped.

Harvesting. Red raspberries are so easily injured that they are handled in pints instead of quart cups. They should be ripe but firm when picked. Over-ripe fruit will not ship. Fruit should not be picked if wet. It decays rapidly after picking, even under the best of conditions, losing color and flavor, and the fruit becomes soft. In hot weather the patch will need to be gone over three times a week. Harvesting may take fourteen to twenty days, varying with the season. It may be extended somewhat by earlier or later varieties. Black raspberries are sometimes harvested as outlined for the red raspberry, but when used for evaporating they are usually gathered in a harvester with a paddle or bat. The harvester is a canvas tray 3 feet square, fixed on a wooden frame, supported by a shoe, so that it can be slid along from bush to bush. A hook is carried in one hand to lift the brambles and a canvas paddle stretched on heavy wire is used by the other hand to beat the ripe berries off. Black raspberries harvested in this manner are allowed to become fully ripe so as to fall readily. The patch is gone over two or three times in the season. The fruits are allowed to stand in boxes or trays in the field for a short time to let the insects harvested with the fruit escape.

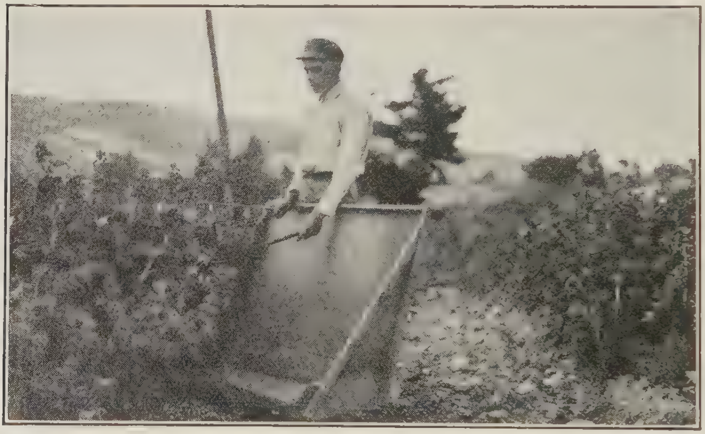


FIG. 124. Harvesting black raspberries for the evaporator with a harvester or "bat." With a wire hook, held in the left hand the canes are drawn over the tray, and the berries are knocked off with the paddle held in the right hand. A man can harvest 5 to 8 bushels a day

U. S. D. A.

Drying raspberries. The fruit is dried in various ways. It may be spread thinly on wooden trays, out of doors, usually taking from three to five days to dry. Trays 12 feet by 3 feet are placed on saw-horses. A strip is nailed across the corner of each tray so that they can be tiered one on another when it rains and be covered up. When dried in a greenhouse a good current of air should pass through at all times. The evaporator is used for commercial quantities. A kiln, as used for apples, is serviceable but muslin must be laid on the slat floor to prevent the fruits falling through. In a stack or tower evaporator the fruit is placed on trays. A 5x5 foot tray will hold 25 to 30 quarts of fruit. These are moved upward and fresh fruit is put in every ten minutes or so. At the start the temperature is often 175 to 200 degrees, ending at the top at 100 degrees. A 25-tray stack is discharged in four or five hours. A strong draught is maintained in the shaft all the time to remove the moisture. The fruit is taken off while it is soft and juicy, and is placed on the curing room floor or in bins to cure; here it remains three weeks and is turned over daily. At this time the berries should be still soft and spongy and such are in much better shape than if dried hard in a short time. With black raspberries from two to four quarts of fresh fruit will make a pound of dry fruit, or a bushel of fresh fruit will make about 10 pounds of dried fruit, depending upon the season and variety.

Yields and costs. The yields of red raspberries may vary from 1,400 to 2,000 quarts per acre. Card reports the average of fifty-six growers as 2,208 quarts per acre. Wilson in New York found the yield on 155 acres in New York to be 1,351 quarts per acre in 1909 and 1,784 quarts per acre in 1910 on 52 acres. The yield of black raspberries may be from 1,600 to 2,400 quarts. Card computed the average yield of fifty-eight growers as 2,493 quarts per acre.

Shipping fresh fruit. Red raspberries are usually shipped in thin veneer crates holding 16 or 24 pints, while purple and black are shipped in 24 or 32 quart strawberry crates. Most shipments are made by express, with or without refrigeration according to the distance. Precooling is advised. Black raspberries will tolerate more delay in handling than red or purple. The Cuthbert red raspberry grown in the Puyallup Valley, carefully picked, graded and shipped in shallow cups, packed in boxes of two dozen to the box, is sent as far east as Pittsburgh. The fruit is precooled before shipment, and sent under refrigeration. All ripe fruit is canned, none but the fit fruit is shipped.

Four grades are made, A, B, C and D. D is the grade which can be shipped 2,500 miles, A used locally and B and C in between. The fruit may be eaten fresh, canned or dried or used for the manufacture of juice, jams and beverages, for flavoring ice cream and ices. It may be stored in barrels with or without sugar and held in cold storage, or frozen near zero or below and then held at about 26° F. and it keeps its flavor well when so handled.

PART V

THE BUSH FRUITS

CHAPTER XLIV

THE CURRANT AND GOOSEBERRY

These two fruits belong to the genus *Ribes* and thrive in the northern regions, although the plants grow in every state in the Union. New York reports one-third of the currant acreage, followed by Michigan, Wisconsin, Pennsylvania and California. New York produces about four times as many currants as any other state. The bulk of the gooseberry crop is grown in the East and West North Central states, Illinois and Missouri leading.

Climate and soil. A cool, moist climate with considerable cloudy weather is most desirable both for currants and gooseberries. High temperatures in June or July, when the fruit is ripening, often scald the crops so much as to make them worthless. This more frequently happens to the gooseberry than the currant. The plants can be grown on almost any soil, but gooseberries prefer a well-drained clay loam, a cool and moist soil and a northern exposure. On a lighter soil they deteriorate. Neither plant will tolerate standing water. Deep rich, friable loams well supplied with organic matter are best. There is little danger of making the soil too rich. The variety planted must be adapted to the local conditions.

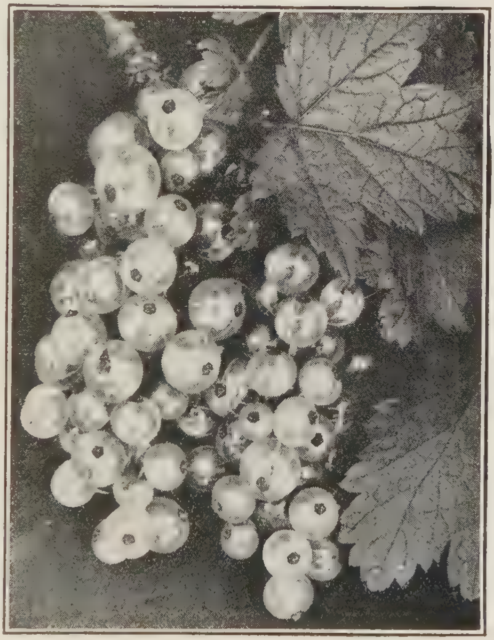


FIG. 125. Perfection Red Currants

Planting. The land should be clean, free from quack grass or other perennial weeds which compete with the crop. Plowing under of a good clover sod is desirable, and an application of rotted manure should be made if it is possible. The distance apart varies—6x6 feet is not too far for most gooseberries and many currant plants in the North, but sometimes they are planted 3x7 feet with the idea of removing every other plant in the row as soon as necessary. Frequently 4x5 feet is advised for garden use, but for large plantings a wider distance is preferable to permit the use of a two-horse spring tooth or disk harrow. The plants should be set deep. Strong yearling or two-year-old plants are used. A good root system is the most important part of the plant. Planting may be done in fall or spring. If done in spring, earliness is best, for growth begins early. A cultivated crop may be grown between the rows in the first two years.

Propagation. New varieties are raised from seeds. The seeds do not reproduce the parent plant. Currants and American gooseberries can be propagated from cuttings 7 or 8 inches long. These are taken in the fall, tied in bunches and buried in sand in a cool cellar or in soil out-of-doors, with the butts up; this permits them to callus. However, they may be planted in fall, leaving the top bud exposed, and covering the row with mulch. English gooseberries and some varieties of currants may be propagated by layering. A branch is bent down in July and covered with soil; it will often be rooted by fall. Another way is to mound the whole bush; as soon as the canes take root they are cut off and transplanted to the nursery row.

The Black Currant is grown to a very limited extent in the United States, but to a greater extent in Canada. It is used mainly for making black currant jam which is highly esteemed by most British people. The Black Currant mite has proven such a menace to the plant in England that it may lead their jam makers to try to secure this fruit where it may be grown with less trouble.

The White Currant is grown mainly for eating out of hand, with a limited demand from a few canners and juice makers.

Pollination. The plants are self-fertile. A single variety may be planted in a block, but usually two or more varieties are planted to extend the picking season.

Cultivation. Frequent shallow cultivation should be given from early spring to harvest. Some growers plow to the plants in fall and plow away a shallow furrow in spring. Another method is to chop the weeds or cover crop with a disk harrow, cross-cultivating early to clean up the patch, and then use one or two-horse cultivators to maintain the patch clean. Pig-weed or lambs-quarter (*Chenopodium album*) and red root make excellent cover crops for currants; failing these, clover, oats, barley or other plants may be used to keep the soil supplied with humus. Annual sweet clover is excellent. In sections subject to heavy snowfall it is advisable to tie the bushes in fall to maintain the upright position of the canes; otherwise they may be pressed flat and it is difficult to cultivate them.

Fertilizers. If manure is not available, a cover crop and fertilizers may be used. A good formula is 100 to 200 pounds of nitrate of soda, 1,000 pounds of Basic slag or acid phosphate, 100 to 200 pounds of muriate of potash per acre. If the plants are not thrifty an additional 100 to 200 pounds of nitrate of soda may be used per acre. An application of a ton of lime per acre every three or four years will frequently aid the cover crop. It is important to keep the land full of humus to get best results from fertilizers.

Pruning currants. Red currants require little pruning from the time they are set until five years old; after that, all surplus and old canes are removed, arranging to have seven or eight good bearing canes to a bush. The aim should be to keep the bush growing upright, removing the limbs that lie on the ground. Black currants bear on wood of the previous year's growth. It is, therefore, essential to maintain an adequate amount of new wood each year. The bush should be pruned to stimulate such growth. Four years is the maximum age for a cane. White currants are treated like the red.

Pruning gooseberries. Five to seven shoots evenly developed make a more satisfactory bush than a trunk with a head on top. It is easy to renew a bush by bringing in a new cane from time to time. When grown as a tree, if the trunk fails, which is usually the case after seven or eight years, the plant dies. Branches resting on the ground should be removed. After the bushes reach maturity at five years or so, a cane or two should be removed each year, and new shoots trained in their places. Shoots growing too strong should be headed back. The open-centered bush should be the aim. The fruit is borne on one-year-old wood and from spurs on the older wood. The pruning should aim to develop size in the fruit; small gooseberries are unsaleable.

Spraying currants. Currants and gooseberries need spraying. Both should receive the dormant spraying with lime sulphur for San José scale, should any be in the vicinity. When currants are out of bloom and the fruit is well formed, a thorough spraying with bordeaux mixture and arsenate of lead should be made. The bordeaux is a 4:4:50 formula, to which 2½ pounds of paste arsenate of lead to 50 gallons of spray mixture are added. This will control currant worms. After the crop is harvested, another spraying is given to maintain foliage and protect against leaf-eating insects. In spraying it is necessary to coat all of the plant, the under limbs as well as those in sight; otherwise the currant worm will effect a lodgment on the under foliage and damage the bush.

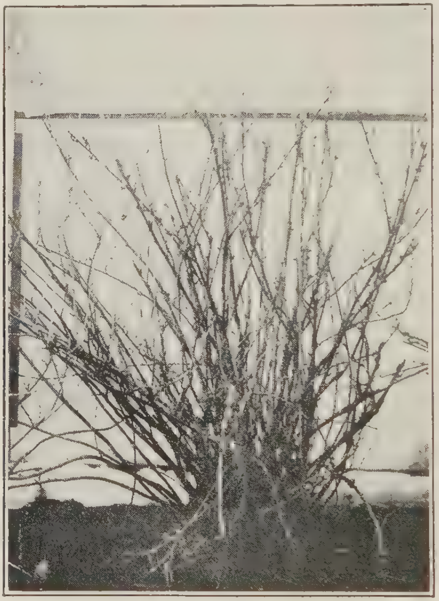


FIG. 126. A Red Currant bush showing too much old wood to be profitable. So much poor wood should not be allowed

Utah Agr. Exp. Sta.

Spraying gooseberries. Lime sulphur is preferred for gooseberries for both the dormant spray and the summer sprays; the first at standard strength for San José scale; the summer spray, 1 gallon to 40 of water, with 2½ pounds of arsenate of lead to 50 gallons of water. Apply as soon as the berries are well formed and again as soon as the fruit is harvested. Some advise that five sprayings at ten-day intervals may be needed to control the mildew on European varieties, but at Geneva, N. Y., one dormant and one summer spray have proven ample.

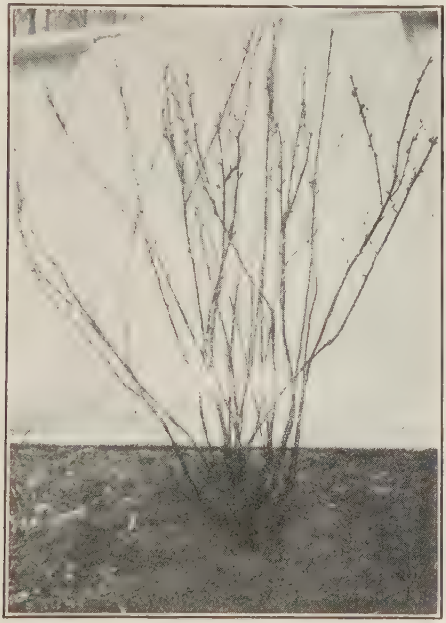


FIG. 127. Thinned out. The same bush as in FIG. 126. It would be better to not let the bush get so thick for now the three and four-year old wood has been sacrificed and it should have done duty for another year or two. Six to eight strong canes are enough *Utah Agr. Exp. Sta.*

Leaf Spot (*Mycosphaerella grossulariae*) is a fungus disease and a common trouble on currants and gooseberries. It causes a brown spot on the foliage, causing death of the part and the leaf to drop. Apply bordeaux mixture as advised, or lime sulphur 1:50, or dust with sulphur. There are other fungi which

Red Spider is controlled by sulphur sprays or dusts of nicotine provided the temperature is 80° F. or above when applied.

Leaf-roller and Currant Span Worm are controlled by the sprays for the currant worm.

The Currant Plant-louse (*Myzus ribis*) lives on the under surface of the foliage and causes it to have a puckered appearance. Usually we do nothing for it, but nicotine sprays or dust would control. The Leaf-hopper is controlled in the same way.

Currant Maggot or Gooseberry Fruit-fly is a difficult pest to control in the Northwest. Good tillage in spring when they are emerging will destroy many. Poultry will also help in the patch.

Harvesting currants. The plants may begin to bear at three years and be in full bearing at five or six. Three tons per acre is a good average yield, seven tons a heavy crop. The fruit should be dry when picked and not over-ripe. The fruit must be picked with the stems on and should not be mushed. Varieties with a long stem above the point where the fruit begins are easiest to pick. Harvesting a patch of one variety will often last seven to ten days An adequate supply of labor for harvesting is often the determining factor in success with these small fruits.

Packages for currants. Fruit for the canner is picked in six or eight-pound grape baskets and delivered direct without sorting. If for shipment to a distant market, quart baskets are used. with 16, 24 or 32 in a crate. The 32-quart crate is in most common use.

Storing currants. The fruit may be held a short time in cold storage, but not long; it soon molds. It needs plenty of air and keeps better in a dry, draughty warm place than in a cooler damp cellar. Carlot express shipments are advisable to insure prompt delivery for long distance shipments.

Harvesting gooseberries. The bushes may bear when three years planted and be in full bearing at six. Three to four tons per acre is a good average yield. Gooseberries are generally picked green, torn off by hands encased in leather mittens. The fruit is passed through a fanning mill to remove the leaves and should be graded into two or three sizes. It is shipped to canning factories in all kinds of packages from quart boxes to bushels, although one-third or one-half bushel baskets are more common. For markets the 32-quart crate is preferred. One cause leaf spot, as *Cercospora angulata*, the cause of Angular Leaf-spot. Treatment as above. Anthracnose (*Pseudopeziza ribis*) is somewhat similar in appearance and effect to leaf spot, and similar treatment is advised. Cane Blight (*Botryosphæria ribis*) is a fungus disease causing one or more of the canes to die as though affected by a borer, but on cutting no burrow is in evidence. Death of a cane or the whole bush may result. No remedy is known. White Pine Blister-Rust (*Cronartium ribicola*) passes one stage of its existence on the currant, particularly the Black currant, although it may live on any currant or gooseberry. It does the currant no harm but it destroys the white pine. American Powdery Mildew (*Sphærotheca morsuva*) attacks the fruit, leaves and twigs of the European gooseberry. It appears as a light gray mold on the surface, which later turns brownish. It destroys the fruit and stunts the plants.

San José Scale is troublesome. Red currants succumb faster than most other plants. Prompt spraying with lime sulphur or some oil preparation is necessary.

Currant Soft Scale. Same treatment as for San José scale.

The Imported Currant Worm (*Pteronus ribesii*). The familiar green worm. Arsenate of lead is the best control, but it must not be applied within a month of harvest. If the fruit is near maturity powdered hellebore, a teaspoonful to a gallon of water, will destroy the worms, but this material soon loses its poisoning power. Old hellebore is not so good as fresh. Another green worm (*Gymnonychus appendiculatus*) does similar work and is common in the West and in Canada. Control as above.

Grape Vine Flea-beetle. It destroys the foliage, sometimes seriously. Arsenate of lead will control it.

Currant Borer causes bushes to be late in coming into leaf in spring. Examine the prunings for borer channels and remove and burn all prunings from such plants.

The Imported Currant Borer (*Sesia tipuliformis*) also seriously injures the plants, and all canes showing such should be cut out and burned as soon as observed in spring.

The Currant-Stem Girdler (*Janus integer*) sometimes attacks the canes, principally on their extremities. The removal of the affected part and burning of same is advised.

reason for picking the fruit as soon as it has size is the danger from sun scald. If a trade for ripe gooseberries should be developed more care must be taken in handling the fruit. When ripe, some of the English gooseberries are excellent for dessert, canning or the manufacture of jam. Gooseberries are used for their juice; currants largely for making jelly, and flavoring other fruits.

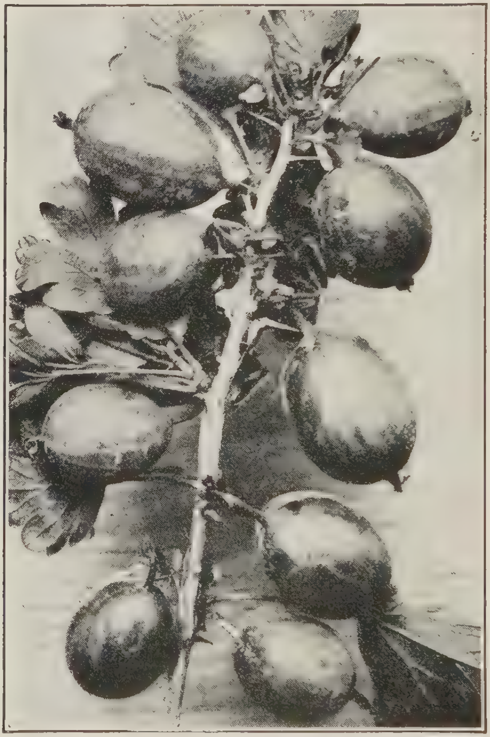


FIG. 128. Industry Gooseberries about half natural size

Grown at Geneva (N. Y.) Agr. Exp. Sta.

PART VI

THE HEATH FRUITS

CHAPTER XLV

THE BLUEBERRY

The blueberry family includes all the plants known under the names blueberries, bill-berries, deer-berries and cranberries. The terms "huckleberry" and "blueberry" have been confused. Huckleberry applies to a group of plants, known botanically as *Gaylussacia*, the most common of which is the Black Tangleberry or Dangleberry, also the black huckleberry. Both belong to the same genus; the former being a shrub growing 3 to 5 feet tall and the latter about 1 to 3 feet. In these, the fruit contains ten cells and each cell contains a seed like a small peach pit. The leaves and branches of these plants are clammy, with resinous dots. The cultivation of these plants is not recommended.

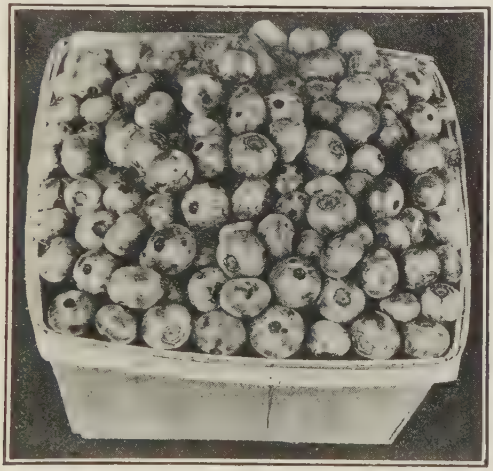


FIG. 129. A quart of Rubel Blueberries. The fruits are large, have a heavy bloom, a pleasant tart flavor and small seeds

Blueberries. The group known by the name *Vaccinium* is more promising than the huckleberry group. Undoubtedly a number could be brought into cultivation. At the present time we have four plants which are receiving attention to some extent. The most important, the Swamp Blueberry (*V. corym-*

bosum) is found throughout moist woods or bogs in New England and other parts of North America. It grows to a height of from 4 to 12 feet, and bears blueberries of excellent flavor. Even the wild plants show a degree of variability; and it is probable that there are many natural hybrids between these and other species. One of its principal requirements is a peaty, acid soil. Some of the hybrids of this species are found distributed throughout the middle Atlantic states and closely related forms extend down to Florida and Louisiana. Distribution is, therefore, extensive. The Swamp Blueberry is in cultivation in Florida.

Low Blueberry (*V. pennsylvanicum*). Some of these grow about a foot high and are found distributed through eastern North America, northward to Newfoundland. The plants are extremely variable in size and shape of the fruits and flowers, but generally the plant is low-growing, prolific, and seems to thrive well on dry, sandy hills. The fruits are bluish-black, relatively large, sweet, and ripen early. This is the plant which furnishes the bulk of the blueberries found in the Eastern markets. The usual plan is to cut the bushes down and burn them off. New shoots come up in profusion, bearing a mass of bloom and fruit which may be literally stripped off by the handful.

Canada Blueberry (V. *canadensicum*). This plant generally grows from 1 to 2 feet tall. The berries are medium or small, blue in color, with considerable bloom. The fruit is more acid than most of the others and matures one to three weeks later. Owing to the acid character of the fruit, it is frequently called "sour-top," and owing to the down on both sides of its leaves, it is frequently spoken of as "velvet leaf." It is usually found growing in low woods and bogs, from Pennsylvania northward. The bushes are quite prolific. Owing to the fact that it comes late in the season, it is in favor, but the fruits are not so sweet as the other species mentioned.

Low Blueberry (*V. vacillans*). This plant usually grows 6 inches to 3 feet tall, is erect in growth, and bears large berries with considerable bloom. The berries are of excellent flavor and ripen even later than the Canada blueberry. It is a very common species throughout the Northern and Central states, particularly west of the Alleghenies, and is one of the two commonest of our upland dwarf blueberries. It thrives on dry, sandy soils and rocky places.

The wild fruits. Most of the blueberries on our markets are gathered from the wild blueberry barrens distributed from Pennsylvania to Maine. The output from Maine is of sufficient importance as to be given a position in the Census. In Maine it is estimated that about 250,000 acres are annually gathered, and estimated returns are about $60 an acre. From 60,000 to 70,000 bushels are shipped to Boston, which in the past have returned about $3 a bushel. Large quantities are gathered in the mining regions of Pennsylvania by the wives and children of miners. The early market has usually been the highest priced. The main crop is produced in New England, with some from Canada, Michigan and Pennsylvania. There is an opportunity for the development of the industry in the more southern regions in order to secure the crop earlier.

Management of the barrens. The wild barrens are usually burned off every three or four years. This is done early in the spring before the land becomes dry, the aim being to burn off the old parts of the bush and any underbrush, thus inducing the bushes to renew themselves and produce strong, vigorous shoots with a material increase in the yield. Like the Phoenix of Mythology, the bush may be burned to the stem, but from the ashes will arise a new bush in all the vigor of youth. The plantation may last sixty or more years. The year before they are to be burned off the fruit may be gathered with a rake, somewhat like that used in gathering cranberries, but in any other year the damage to the bushes would be too great. The rake is not used on the high bush blueberries. A hand-picker will usually gather about a bushel a day; when using a rake, about three bushels a day, but the product would have to be hand cleaned.

Soil. A peaty, sandy, acid soil properly supplied with a moderate amount of moisture and relatively rich in organic matter provides the right conditions. These plants thrive in soil so acid as to be considered worthless for ordinary farm crops, and will not thrive on a soil that is at all alkaline, or even neutral in reaction—such as an ordinary garden soil or rich field soil. They need an adequate amount of moisture and good drainage. Another factor equally important is the presence of a root fungus which appears to be able to supply this plant with plant food in a somewhat similar manner to the organisms on the roots of clover and other leguminous plants. This group of plants thrives when this symbiotic relationship is present.

Propagation. Some success has followed the transplanting of the wild bushes onto poor, rocky, upland soils and setting them out 6 to 8 feet apart each way and mulching them with leaf mold, spent tan bark, leaves, etc., but this is capable of but limited expansion, unless used merely for propagation purposes. In selecting plants the important feature is size of the berries. Large berries are much more easily picked than small ones and they bring a better price. Other considerations are color, flavor, time of maturity of the fruit, vigor and productiveness of the bush. Blueberries that spread by root stocks, such as the low blueberry and other related plants of the same habit, may be propagated without difficulty by root-stock cuttings. These are easier to propagate than the high bush blueberry, since this plant does not usually produce root stocks.

Budding and grafting. Both budding and grafting may be used in propagating desirable varieties, but the tendency to form suckers is so pronounced that it is not satisfactory. Budding is usually performed during the middle of July to the end of August. The plants should be protected from direct sunlight, and care taken that the raffia used for tying the bud does not get wet during the first two or three weeks after the operation.

Stumping. In some cases the plants may be induced to form layers just as practiced for gooseberries or currants. In the early spring the stems of the plants are cut off relatively close to the ground and the stems are then mounded by covering to a depth of 2 inches with a mixture of clean sand and 20 per cent of peat. This is kept moist except at the very surface, with the result that the new stems partake of the character of root stocks while they are passing through the sand. When they reach the surface they produce leaves and a stalk. From this artificial root stock, roots will develop during the season. The following spring these plants are moved before growth is started; their tops are cut back to three buds and they are planted in 3-inch pots containing soil made up of two parts of rotted upland peat and one of sand, with perhaps one of broken crock mixed in to insure drainage. These are placed in a shaded cold frame or greenhouse which is amply lighted, but from which direct sunlight is withheld. It should be held at a temperature of about 65° F. If it goes too high they may rot. They should be watered sparingly to keep them moist and must not be over-ventilated or allowed to become overheated. The plants are not safe until they have started to produce a second growth of twigs. In other words, the procedure is to send up small twigs which in time become hard and woody and from this a new wood growth takes place. When this has happened, the plant is considered to be established. It may need replanting into a larger pot in a soil made up of clean or washed sand, one part; upland peat rotted, nine parts, and perhaps three parts broken crockery. Loam or soils containing lime or even manure are decidedly detrimental. The peat procured from Kalmia or Laurel thickets seems to be best. Rotted oak leaves and leaves from oak and laurel thickets are esteemed. It will be thus seen that production of the plants by this method is quite expensive.

Cuttings. In making cuttings* it is essential that the plant be thoroughly exposed to freezing weather before any cuttings are made. The cuttings may be chilled for a couple of weeks before planting; otherwise they refuse to grow. If the plant be kept warm, the starch in the cells stays as starch, instead of changing to sugar as is necessary in order that growth may be made; so that cuttings are usually made in early spring unless artificial chilling is employed. It is usually advised that the cuttings be laid horizontally in a shallow well-drained box containing a bed of clean sand, and covered with one-half inch of similar material. This should be well watered and kept at a temperature of 60 to 65° F. If kept damp, a second watering may not be needed for some time. In about six weeks shoots may appear through the sand, at which time the box may be placed in good light, but protected from direct sunlight. The temperature should be maintained at as near 65° F. as possible. When the first shoots cease to grow and their foliage is a mature green color, the plants are ready to make roots. About one-half inch of sifted, rotted peat should be scattered over the surface of the sand bed and may be thoroughly wet down. This should then be retained in a saturated or nearly saturated atmosphere until new shoots cease to appear. In the meantime the older shoots will have formed roots, between the surface of the ground and the point at which they sprang from the cuttings. When well rooted, the young plant will make a second twig growth and this is the best evidence that rooting has actually taken place. The plants may separate themselves from the parent cutting, or they may be separated with a knife and kept in two-inch pots in a blueberry soil mixture as outlined. It is advisable to keep the pots in sand, because if the surface of the pot becomes dry it is apt to kill the roots of the plant, which have spread all around the surface of the pot in search of air.

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* The methods are those outlined by Fred V. Coville of the United States Department of Agriculture.

Plants in pots should be given shade because if exposed to the hot sun the young leaves and the growing part are apt to be burned. On cloudy days the shade may be removed. In winter, cuttings or year-old plants should be placed outside and the soil well mulched with leaves—preferably oak leaves. They are much better handled in this way than by keeping in the greenhouse. The plants from cuttings or rooted shoots may be ready for fall planting when two to three years old or when about 1½ to 2 feet tall. They are usually set out in August or in spring before the buds are started.

Commercial practice. Cuttings about 3 to 4 inches long are made in early August as soon as the wood is hard enough, and are chilled for several days. They are then planted in a sandy, peaty soil in cold frames about 1 to 3 inches apart under shade. They callus, and in the spring make a short leaf growth, followed by a resting period during which they make roots. If rooting is successful they send out a new growth during the summer; when this is made they are re-potted with a ball into 3-inch pots and plunged in a cold frame, in sand, and under shade if necessary, and given a protection of leaves for the winter. They are grown until two years old and may be planted in the field in August or in the spring, August being preferable, since the plants make roots from that time on until November or later. It is important that the roots extend outside the ball of soil and into the new soil as soon as possible. In spring planting it not infrequently happens that the plants use up all the moisture in the ball before root connections are established and unless watched may be too dry to start into growth.

Laying out a plantation. The most favorable location is a boggy area, in which is a sandy sub-soil with a layer of peat above, with hard pan 2 to 3 feet below the surface. The land may be drained by tile laid on the hard pan. It is preferable that the peat be of sufficient thickness so that in plowing, a slight amount of the sand may be included with it. This would constitute an ideal condition. The bog may be ditched so that water may be introduced to maintain the water table about a foot below the surface during the growing season, or to subirrigate during drought. The ground should be plowed 8 inches deep and thoroughly harrowed for a season in order to kill any vegetable growth thereon. Plants may be put out during the last of August or early spring, usually 8 feet apart each way, or 8 feet by 4 feet, with the expectation of removing half the plants later. They are set about half an inch deeper than they were. Cultivation should not be over 2 inches deep; otherwise the roots may be injured. If conditions are congenial the foliage will stay green until crimsoned by frost. If the water supply is short the leaves will turn brown and wither along the edges. If the leaves turn red or purplish before frost the soil is too wet.

Managing a patch. For those not having favorable conditions a trench may be excavated 4 feet wide and 2 feet deep and filled with two to four parts peat or half-rotted oak leaves and one of clean sand, and the plants set in this. If the supply of organic matter be limited the plants may be mulched with peaty material as oak leaves, sawdust, decayed wood, spent tan bark, and this may be increased from year to year, the root area being kept coated with the mulch. Clean cultivation should be given, but it must be shallow, about 2 inches deep. During the third season the plants make considerable growth and usually bear a commercial crop. In New Jersey 600 pounds per acre of a fertilizer made up of 170 pounds nitrate of soda, 230 pounds dried blood, 340 pounds steamed bone meal, 340 pounds phosphate rock and 170 pounds potassium sulphate, proved beneficial on sandy land. The swamp blueberry does not require annual pruning. When a stem becomes unproductive it should be removed. If the whole bush is in this condition cut the top off after the plants have become dormant. To maintain vigor in the bush, in August or later, remove any stems which are a year old or more which have not made a vigorous twig growth that season. This is done after harvest and keeps the bush vigorous. Burning off is not a good method of managing cultivated bushes. It causes the loss of a season's fruitage which is unnecessary.

Production. In New Jersey, selected plants set out 3 to 5 feet apart (which is too close to leave permanently) have produced 20 bushels of fruit per acre. Two quarts were secured from a single bush at three years of age. These plants begin to bear when three years old and usually they are expected to attain good bearing at six to eight. In other places they may be expected to bear in about five years after planting, when the plants are 3 to 4 feet high. From that time on they increase slowly in size until they reach full bearing.

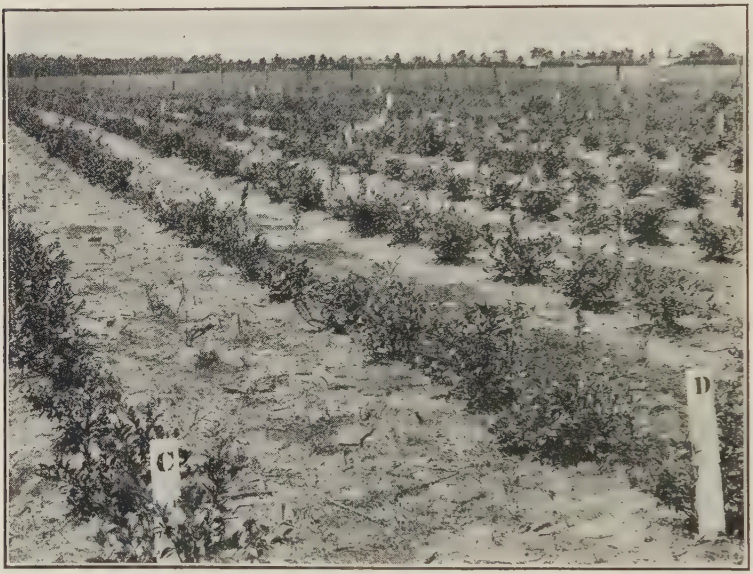

FIG. 130. A Blueberry patch at Whitesbog, New Jersey, showing plants in their third year

At Elkhart, Indiana, a small plantation of two and one-half acres in extent, started in 1889 in a natural, but drained, blueberry bog and set with unselected wild blueberry bushes, yielded as follows:

	Quarts per acre	Price per quart	Receipts
*1910	1040	17⅛	$178.25
1911	5620	.12⅞	725.25
1912	5900	.12⅞	758.25

* Late spring frosts reduced the crop.

The expenses in connection with this bog were as follows: weeding, cultivation and irrigation, $50; cost of picking, 5 cents a quart; general cost of maintenance of equipment, $5 a year; charge for interest, $30;

taxes, $5, and depreciation, $10. The profits per acre although no allowance was made for labor of the owner, are stated to be: in 1920, a bad frost year, $10; 1911, $139; and 1912, $147. The average yield for a six-year period of this bog was 1,741 quarts per acre, which was sold at an average price of 14½ cents a quart. The average net per acre for the six-year period was stated to be $116. In this case the plants were unselected in regard to productiveness and size of berries. With selected plants, it is believed the yield would be greater, the berries larger and would bring a better price. The cost of picking would also be less.

Pollination. The plants are sterile to their own pollen. A patch should not be planted with cuttings from a single bush; at least two plants should be used and these should be of different varieties. At present, it seems advisable to plant a row of one and then a row of the other, alternating. Bumble and other bees aid pollination. The honey bee does not possess a tongue long enough to do the work.

Moving mature plants. In moving wild or cultivated plants which have attained some size, it is important to retain as much as possible of the old root mat. This is done usually when the plant is not in leaf. It is important to remember that the plants do not send out new roots in spring until in full leaf and the flowering is nearly or quite finished and until the twig growth has practically ceased. All growth made by the plant after removal depends upon the functioning of the roots left on it. Since it is seldom possible to take very much of the root with a plant, it is generally advised to cut a disk 3 or 4 feet in diameter and remove as much as possible of the roots. Remove all the top, using it for cuttings if the plant is particularly valuable.

Harvesting and shipping. The berries are usually gathered in quart baskets and shipped in 24- or 32-quart strawberry crates. The best fruit is gathered by hand. So far, shipments have not been made to any great distance, those from Maine to Boston; but the indications are that the fruits can be shipped in refrigerator carlots or by express almost as well as gooseberries. The fruit is held in cold storage. The early market is usually regarded as the best.

CHAPTER XLVI

THE CRANBERRY

Unlike currants, gooseberries and raspberries which are grown in every back-yard, the cranberry (*Oxycoccus sp.*) is a specialized crop. It is grown on relatively few farms, not one in 1,500. Nearly half the acreage is in Massachusetts, over one-third in New Jersey and a lesser acreage in Wisconsin, Oregon and Washington, and a small acreage in Nova Scotia. The industry has developed rapidly in the last twenty years owing to improved methods in cultivation. marketing, grading and packing.

There are three cranberries: The small or European Cranberry (*Oxycoccus oxycoccus*), the large or American (*Oxycoccus macrocarpus*), the Little Mountain Cranberry (*Oxycoccus erythrocarpus*). The large native cranberry is the one used. It grows on highlands as well as in swamps, but in the latter the crop is more sure. Therefore low, boggy lands are selected; the soil under such conditions being cool and acid. The plant is a vine. Runners are sent out, growing several feet long. Upright shoots grow on the runners, attaining a height of 4 to 10 inches. These cover the ground closely, giving it the appearance of a meadow. Each upright may bear one to seven berries. Some plants bear fruits an inch long and from one-fourth to three-fourths of an inch in diameter.

Location of the bog. The ideal location furnishes a suitable soil, opportunity for adequate drainage and an abundant supply of readily obtainable sand and water. It must duplicate the wild bog as closely as possible. It must have a water supply which can be regulated. A live stream is best. The water may need to be drawn off or applied. The soil should be sand on the surface with clay or other impervious layer 2 feet down, to hold the moisture. The surface must be level so that the bog can be covered with water to a uniform depth. An acid soil is essential. Some growers esteem a peaty or muck soil highly. In other places, sandy muck soils are selected. Clay soils are apt to produce vines which run to foliage. Uniformity of the soil is desirable, otherwise the bogs are apt to be streaky.

Plant Indicators. The bogs chosen for clearing are those which contain moss or sphagnum, with a peaty or mucky soil and a subsoil of clay. If heath-like plants abound and Cassandra or leather leaf are growing, these are good soil indicators. Cedar swamps and land growing black ash, red maple and swamp huckleberry indicate desirable locations. Some of these plants and others are apt to appear as weeds among the cranberries, and must be removed.

Preparation of the bog. The trees including roots of bushes and moss are first removed. Surface ditches are cut to drain off the water. They are used also to take water onto the bog by damming. A large bog may require a main ditch through the centre, with smaller ditches at intervals. Seepage water must be cut off, otherwise the bog may be too cold or too wet. Good drainage is absolutely essential. The water table should be from 1½ to 2¾ feet below the surface and should be adjustable. The bog is then levelled and sanded, preferably with coarse sand, to a depth of about 4 inches because it works easily, simplifies planting and gives better aeration; the vines are rendered less

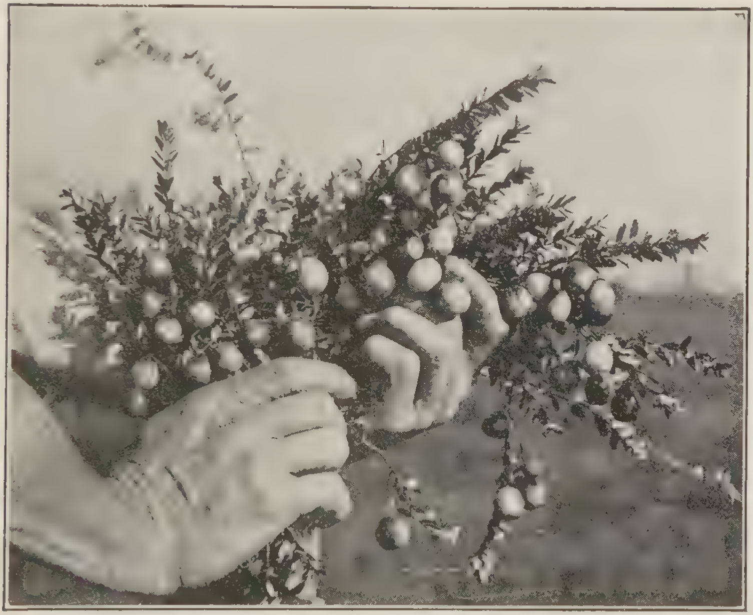

FIG. 131. Cranberries on the vine. The cranberry grows on upright shoots
Brown Bros. Co.

vigorous but usually are more productive. The bed must be weeded for the first three years and kept clean; later the plants cover the ground.

Resanding. Sanding is done every second or third year to a depth of half an inch to 1 inch, thus covering some of the runners. These take root and become individual plants, thus encouraging the growth of more uprights and increasing the yield. Sometimes it pays to apply an inch of sand at a time. The amount to use requires judgment. In one case, with vines six years planted, the following results were secured:

Results of Sanding Cranberries

Plat	Amount of Sand	Yield Per Acre, Barrels
1	none	16.5
2	¼ inch	25.5
3	½ inch	87.0
4	1 inch	151.0

Sanding may be done in the fall, in the winter on the ice, or in early spring. In Cape Cod it is wheeled onto the bogs in barrows. In some districts it is hauled on by teams on movable roadways of light plank. About 135 cubic yards of sand are required to cover an acre to the depth of 1 inch. The sanding prevents the bog from getting soil bound and is held to be an effective insurance against loss of crop from frost.

Varieties. Three types are generally grown and known by their shape: the Bell, the Bugle and the Cherry; of these there are several varieties. In Massachusetts such varieties as Early Black, Howes, Matthews, Centreville, Chipman and McFarlin are popular. The first two varieties constitute 75 per cent of the saleable crop of the United States. In Wisconsin, Bell and Cherry, Searles Jumbo, and Bell and Bugle are the principal varieties grown. In New Jersey, Early Black, Late Jersey, Late Howes and Centennial are in the lead. The varieties vary in shape, size, color, flavor and keeping qualities. The Early Black is the only variety on the market from September until the middle of October. After that time other varieties are ready.

Planting. The beds are usually planted with cuttings, which consist of portions of vines of the variety to be grown. They may be 8 inches long and usually three or four are pushed in a place, using a broad, thin wedge-shaped dibble. The plants are placed either 18x18 inches or 18x9 inches in some places they are planted 12x12 inches and are expected to bear a crop in three years. About 2,000 pounds are required to plant an acre. Care must be taken that they do not dry out in sorting and planting. Planting is usually done in early spring. May is better than June or July, and care should be taken to push the cuttings through the sand into the good soil beneath it.

Management after planting. After planting, water is let in to moisten the soil but the plants must not be drowned out. On frosty nights, after the vines have covered the ground and are ready for fruiting, water is let on the beds to the surface of the ground. The water being warmer than the air, it will prevent frost from settling and damaging the buds, but it must be drawn off next day. A very critical time is when the plants are making new shoots in spring. If these are set back

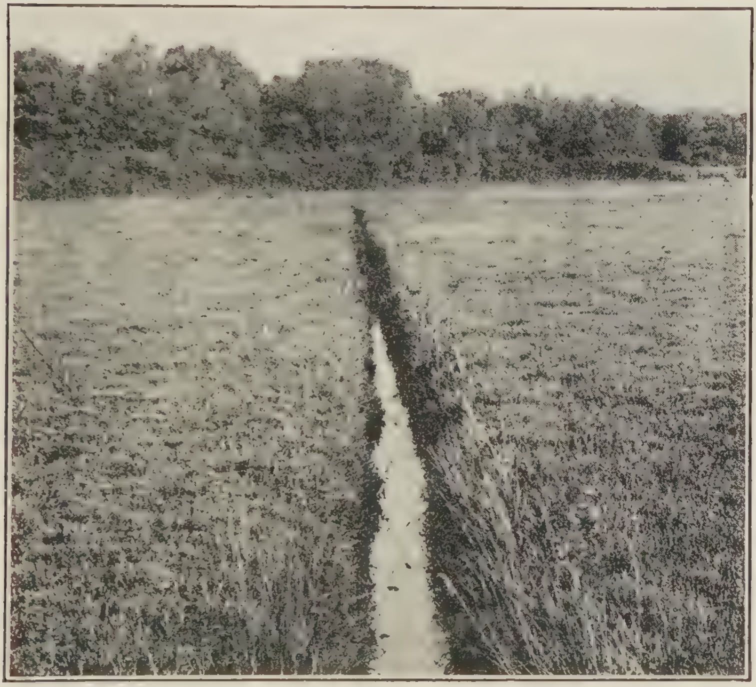

FIG. 132. A cranberry meadow. The ditches are cut at regular intervals and are used to let water on to the bog and to take it off. The plants grow but a few inches tall

Courtesy Am. Agr. Chem. Co.

that year's crop is decidedly injured. When the plants are in bloom in July, the beds must not be permitted to get too dry. If the weather becomes very hot the flowers may fail to set fruit. At the end of the second season a light coat of sand will fasten down the runners and aid vine growth. In the hot season, judicious use must be made of the water, but the plants must not be flooded while in bloom. In a season of drought, water may be applied once a week but it must not remain for long. In winter the beds are flooded, usually in November, and the water is left on until the spring frosts are over. The new shoots are easily hurt by frost; hence the reason for using water to ward off that danger by flooding the beds. After they have been uncovered for a few weeks, the plants harden and withstand the frosts.

Frost has done more damage to cranberries than all other agencies put together. Flooding is the means used to prevent injury. If a severe frost is expected, the bog is flooded entirely, early in the evening; if a light frost, running the water in the ditches may be ample. It is a matter of judgment. Thermometers are placed in various parts of the bog to determine the temperature. A bog well sanded and free from weeds is less apt to be hurt than a weedy bog.

Flooding. In the best bogs, not more than an hour is required to flood a 20-acre section, and two to four hours to flood a large bog. Quick flooding is often a primary requisite; and it is equally important that facilities be furnished for quick removal of the water. Concrete bulkheads are used in Massachusetts in some places, in others wood and iron. The practice of holding the winter flooding on the bog until the end of June on Cape Cod and in New Jersey until July 10 to 15, has frequently proven beneficial. It destroys the grasses, weeds and insects and gives the vines a rest without doing them injury. A crop is lost that season, but that is more than made up the following year. It is so much cheaper than any other means now known of cleaning a bog.

Fertilizers. In some bogs nitrogen in the form of nitrate of soda is a valuable fertilizer but in others it is not. Four years' work in New Jersey shows that on sandy bottoms a complete fertilizer did better than fertilizers furnishing one ingredient. Complete fertilizers gave poor results on mud bottoms. In New Jersey, 600 pounds per acre of a fertilizer consisting of 200 to 300 pounds of cottonseed meal, 50 pounds of nitrate of soda and 200 pounds of acid phosphate or ground rock phosphate proved remunerative. Another mixture of steamed bone meal, sulphate of ammonia and muriate of potash proved useful. Potash appears to be the least essential of fertilizer ingredients. In same cases the use of ground lime at the rate of 1½ tons per acre proved profitable, but generally speaking, liming is not recommended for cranberries, blueberries, azaleas or rhododendrons, all of which belong to the heath family.

Pruning. When the vines get too thick and woody they may be pruned with knife rakes. These are always used in the same direction as the scoops were used in picking. The work is usually done in the fall or early spring. The natural tendency is for the vines to run in a southeasterly direction and all pruning and scooping begins at the northwest corner of the section, proceeding diagonally across the section. Heavy pruning can be done at the rate of a quarter of an acre per day by a good pruner, three quarters of an acre can be done when light pruning is given a well-kept bog.

The estimated cost of establishing a cranberry bog under clean cultivation in the pre-war year of 1914 is shown in the table below:

Cost of Cranberry Bog

	Per Acre	Per 40 Acres
Scalping or plowing	$ 30	$ 1,200
Levelling and grading	50	2,000
Ditching	15	600
Bulkheads or flumes	25	1,000
Dikes, dams or roadways	25	1,000
Sanding 3 inches deep	60	2,400
Vines, one ton	150	6,000
Weeding, first season	20	800
Weeding, second season	25	1,000
Weeding, third season	25	1,000
Weeding, fourth season	25	1,000
Resanding ¼ inch deep, third and fourth winters	25	1,000
Management for four years	80	3,200
	$555	$22,200
Estimated yield from crop, end of third season	10 bbls	400*
Estimated yield from crop, end of fourth season	30 bbls	1,200*
Estimated yield from crop, end of fifth season	40 bbls	1,600*

*This is above average crop.

Total yield at end of four years, plus one growing period of four months (four years old)	80 bbls	3,200*
Cost of harvesting, cleaning and packing above crop, average for first three years, $4 per barrel	3,200 bbls	$12,800

To complete figures add interest on investment and taxes. Labor is figured on basis of $1.75 a day. Sanding is figured at 15 cents per cubic yard for moving. Cranberry vines are figured at $150 per ton. For post-war period, cost would be at least 60 per cent greater.

Insects and diseases. Cranberries are subject to many diseases and insect troubles, but the growers have a happy way of flooding the beds to get rid of some of the insects. Spraying with arsenate of lead, 2 pounds of dry or 4 pounds of paste to 50 gallons of water, is, however, sometimes resorted to. By sacrificing a crop and holding the winter flowage until midsummer the pests may be so reduced that the results are in evidence for some time. The succeeding crop is often of unusual size and has excellent keeping quality.

The black-headed cranberry worm (*Eudemis vacciniana*), the yellow-headed cranberry worm (*Alceris minuta*) and the cranberry fruit worm (*Mineola vaccinii*) are all serious pests. The last named does considerable damage at times by eating its way into the berry, thus causing it to fall; it then passes on to another. Retaining the winter flooding as late as possible is suggested as a means of control. Spraying with arsenicals is also practiced. With the false army worm (*Calocampa nupera*), either spraying as mentioned, or flooding, is practiced. Any worms which reach the shore are destroyed with a kerosene torch. The fire worm can be controlled if the bed can be flooded for a few hours about four weeks after the winter water is removed.

The Girdler (*Crambus hortuellus*) is gotten rid of by flooding immediately after harvest. The Cranberry Fulgorid (*Phylloscelis atra*), a small jumping insect, may be controlled by a contact spray as black leaf 40, 1 pint to 100 gallons of water and 4 or 5 pounds of soap or resin fish-oil soap, 4 pounds to 100 gallons. The damage resulting from the tip worm which works on the bud is reduced by sanding. Certain Katydids eat the seeds. Bogs free from weeds are not usually attacked.

Scald (*Guignardia vaccinii*). Various diseases such as scald, rot and anthracnose cause the fruit to decay. Scald, a fungus disease, attacks the fruits, flowers and leaves. It gives the fruits a watery appearance. Spraying with bordeaux mixture 5:5:50

to which 4 pounds of resin fish-oil sticker is added is advised. Five applications at about fifteen days intervals, beginning in early June, are suggested. The selection of resistant plants, good sanitation and maintaining good growing conditions is advised.

A common rot is caused by the fungus (*Acanthorhynchus vaccinii*). Anthracnose, bitter rot, is caused by the fungus (*Glomeralla cingulata*). The treatment for both is as for scald. Gall caused by the fungus (*Synchytrium vaccinii*) appears as a red rust or galls on stems, leaves, flowers and fruit, is carried in the water. Withholding winter flooding is suggested. The "Rose Bloom" (*Exobasidium oxycocci*) frequently attacks late varieties. In Massachusetts a two- or three-day flooding in June when the terminal buds are ready to break has caused the death of the affected buds. The "end rot" is caused by *Fusicoccum putrefaciens* and the rot caused by *Sporonema oxycocci,* which causes small spots on the fruit, are both found on fruit in storage.

Spraying. In New Jersey the spraying program for diseases consists of a bordeaux spraying immediately after bloom with another application two or three weeks later. In some cases the machine is hauled along the roads which divide the sections and by means of a long hose the men spray the bogs, taking a certain width, applying the spray with a swinging motion. About ten acres a day can be sprayed with a good machine. The wisdom of using bordeaux mixture to control diseases is questioned by some. The claim is made that it has an injurious effect upon the roots of the plants, and the same statement is made in regard to the use of arsenical poisons.

Harvesting. Harvesting generally lasts five to six weeks during late August and September in New Jersey, Massachusetts and Wisconsin. It begins about the middle of September in Nova Scotia. Most varieties are picked before thoroughly ripe, but if picked too green, they shrivel. Harvesting was formerly done exclusively by hand, but today a specially constructed scoop is generally used. With this tool a person may gather 75 to 80 measures of 6 quarts each a day, or double the amount secured by hand picking. The beds are divided, each picker being given a space between two strings so that no part of the bed will be missed. Four bushels is an average day's work for hand picking. The men handling the rakes are frequently employed by the day.

Water-raked berries. Cranberries can be harvested quickly by flooding the vines so that the berries float near the surface of the water and are raked off. These are known as "water-raked" berries. This practice has been entirely abandoned in Massachusetts, New Jersey and Long Island. Cranberries harvested while wet or even damp, regardless of any drying they receive, are regarded as of doubtful storage value.

Care after harvesting. After harvest, the bog may be flooded. This helps the vines to recover from the shock of scooping. Before flooding for winter, any weeds may be cut off. Some of the successful growers sand every fall or every second year.

Cleaning the fruit. All fruit is gathered at one picking. It is taken to the storehouse and held until ready for shipment. Broken branches, leaves and injured fruits are removed, partly by fanning mills, also by hand sorters who look over the berries in much the same way as beans are handled by the bean pickers. The fruit is sorted and put into barrels or boxes, as desired. The condition of the meadows, time and method of harvest, method of handling in the warehouse, construction of the warehouse and the way in which the berries are sorted all effect the cost of cleaning. Three hundred barrels of relatively clean fruit can be cleaned as easily as fifty barrels of poor. Rough handling is detrimental. Hand sorting must supplement machine grading. The berries are passed from the storage room through the sorting room on a belt conveyor, passing in front of the sorters and back into storage to be barreled.

Storage. The fruit is usually held in storage at the bogs, from one week to three months after harvest. Usually small open boxes are used in the storage houses to hold the fruit, or these boxes may be held in a tent near the bog to permit the berries to cure. The usual storage house has many windows, and roof ventilation. A good dry basement is desirable. The fruit must be kept dry and cool. If put into barrels as picked, it will heat in a few hours and diseases will develop. Placing the fruit in a well-ventilated storage retards respiration and the growth of rot-producing fungi.

Cranberries need adequate ventilation but an excessive amount may cause a heavy shrinkage. In the case of Early Black berries a shrinkage of 10 per cent took place between October 10 and January 14 without any loss from decay. The shrinkage from the time of harvest, September 20 to October 10 was considerable. Shrinkage is most rapid immediately after picking.

Scoops are usually made 15 to 22 inches wide with teeth 10 inches long, made of wood or metal. The scoop is inserted into the vines just about the laterals; by an upward movement the berries are pulled off and fall into the back of the scoop. When the scoop is partly full it is emptied into the bushel crates.

The separator. The berries are run through a separator. The fruit is emptied into a hopper and passed through a blast of air created by a fan which blows out the leaves, vines and light dirt. The fruit then falls on bounding boards which separate the soft and decaying stock from the sound. The fruit may be sized, and the wormy and imperfect specimens removed by hand.

Barreling the fruit. The standard barrel holds 100 pounds and weighs 115 pounds gross when packed. The barrel is filled and shaken down while being filled, and the head is pressed into place by a barrel press. Slack packed barrels are not wanted. The half-barrel box is growing in favor; it holds fifty pounds of fruit. It shows the fruit much better than a barrel. In 1921 about 35 per cent of the crop was boxed. The western fruit is shipped in a ventilated box holding one-third barrel—33 1-3 pounds.

Yield and prices. The average yield per acre is estimated at about 2,100 quarts. It may average nearly 4,000 quarts in favorable seasons. The average price received by the growers in pre-war times was about 5½ cents per quart. The best growers do better. The fluctuation in yields and prices is shown in the table following.

Cranberry Yields and Prices (1914-18)

State and year	Acreage	Average yield per acre barrels	Production barrels	Average farm price per barrel	Farm value Dec. 1
Massachusetts .	14,000	14.3	200,000	$12.50	$2,500,000
New Jersey . .	11,000	10.4	114,000	8.50	969,000
Wisconsin . .	2,200	16.4	36,100	9.00	325,000
Total of above	27,200	12.9	350,100	10.84	3,794,000
1914 . . .	22,000	31.7	697,000	3.97	2,766,000
1915 . . .	23,100	19.1	441,000	6.59	2,908,000
1916 . . .	26,200	18.0	471,000	7.32	3,449,000
1917 . . .	18,200	13.7	249,000	10.24	2,550,000
1918 . . .	27,200	12.9	350,000	10.84	3,794,000

Advertising. In 1916-17 the American Cranberry Exchange expended $22,941 in advertising in Chicago as a test. This lead to a national campaign of advertising which has been maintained annually since. In 1919 $122,697 were expended in advertising, and although the crop was 20 per cent above the average in yield, the money received was nearly 30 per cent above average; in other words a price of 10 per cent above average was secured. The publicity of the previous years had cumulative value. The 1920 crop was but 7 per cent below average, but the money received was 30 per cent above the average. In 1921 the crop was 20 per cent below average but the money received was 50 per cent above the average.

A STUDY IN MARKETING

The story of Fifteen Cranberry Crops. Showing the annual crops of cranberries in barrels, from Massachusetts, New Jersey and Long Island and Wisconsin, the total value of the crop each year and the average crop and value for the fifteen-year period

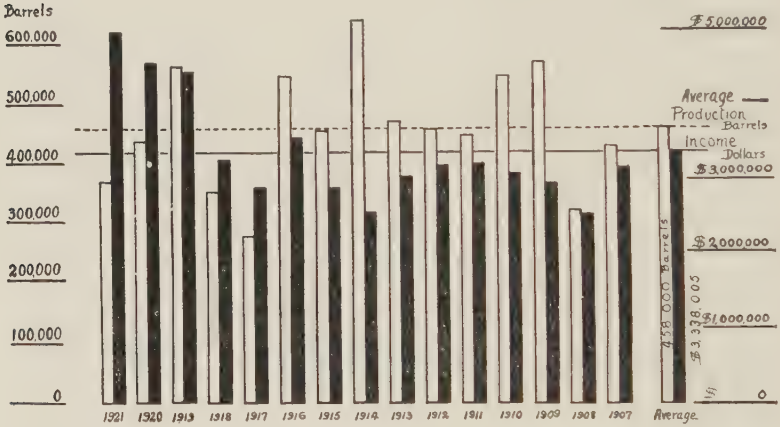

FIG. 133. The large crops of 1909, 1910 and 1914 returned the growers less money than the smaller crops of 1907, 1911 and 1912. As the crop declined in volume from 1919 to 1921 the actual amount of money received by the growers increased

The American Cranberry Exchange does not market all of the cranberries. In 1914 it controlled but 38 per cent of the Cape Cod crop and but 50 per cent of the crop grown. In 1919 it distributed 60 per cent of the total crop, and in 1921, 66 per cent.

Grades. Cranberries are graded and shipped under a brand. Eighty brands are in use. In Massachusetts, Early Blacks are divided into six grades according to the size and color of the fruit. The late Howes are divided into five grades. In New Jersey, the late Jersey is divided into four grades, the Centennials into three. In Wisconsin each variety is graded into two or three grades; a separate brand is given each grade. The Fancy and Extra Fancy grades carry the prefix "Eatmor," which is the trademark of the Cranberry Exchange. Fancy berries are graded over a five-eighths inch screen; medium size, over a thirteen-thirty-second inch screen and small berries over a nine-thirty-second inch screen.

Cranberry barrel. The United States standard barrel for cranberries has the following dimensions: Length of staves, 28½ inches; diameter of head, 16¼ inches; distance between heads, 25¼ inches; circumference of bulge, 58½ inches, outside measurement; the staves are not greater than four-tenths of an inch in thickness.

Standard carload. At present the minimum carload is 24,000 pounds. For convenience in loading it is understood that a carload is 225 barrels; 700 crates, more or less, may be loaded according to the size of the car. Barrels are always piled on the bilge.

Wolf Berry. In Nova Scotia, the low-bush Cranberry or Wolf Berry (*Viburnum vitis-idæa*) is gathered and shipped to Boston and other places. This fruit is also found in Europe, where it is highly prized though it is not as yet in cultivation. The imports made of this fruit from Nova Scotia and Europe are worthy of mention.

The Tree Cranberry (*Viburnum opulus*) or cranberry bush is an entirely different plant. It is native in North America and bears bright scarlet berries which hang all winter. From it has been developed the Guelder Rose or Snowball in which the flowers are sterile, but much more showy. The fruit is very sour, but more agreeable than that of the cranberry of commerce, and makes very good sauce and jelly. The plant is perfectly hardy and can be grown on almost any soil or location. Various named varieties are of considerable commercial promise.

The Ohelo Berry of Hawaii (*V. reticulatum*) is the Hawaiian cranberry. It thrives on elevations of 4,000 feet or more. It is a low shrub, bears reddish green solitary flowers in the axils of the leaves, which give place to yellow or rose-colored fruits about one-third inch in diameter.

PART VII

THE STRAWBERRY

CHAPTER XLVII

THE STRAWBERRY

The strawberry (*Fragaria spp.*) is the most important of all the small fruits. During certain years it is more valuable than the plum and prune crop; than all our apricots, cherries and nuts, and twice as valuable as pears. The crop is grown in every state. The greatest concentration of the crop is along the Atlantic Coast in Delaware, New Jersey and Maryland.

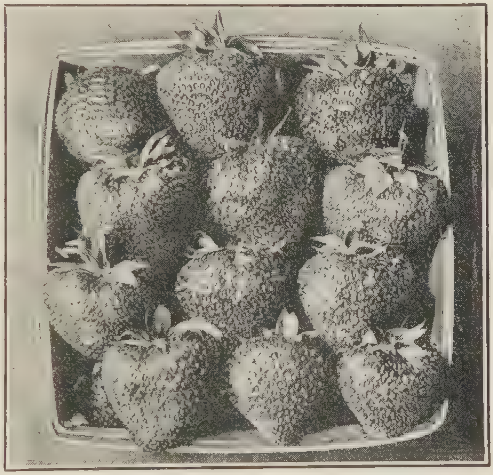

FIG. 134. A handsome quart of strawberries. The main crop is usually shipped in quart boxes. The fruits should be firm, of good color and uniform

Growth of the industry. The remarkable growth in this crop is more appreciated when it is known that the strawberry was not a commercial crop previous to 1840. At that time it was known only as a wild fruit. It was the introduction of the variety Hovey seedling in 1834 or 1835 that started the strawberry business. The introduction of the Wilson in 1854 revolutionized it and made it possible for anyone to have a strawberry patch. Since 1855 development has been rapid.

Soil. Strawberries are grown on all types of soils, from light sandy loams to compact clays, but generally speaking, a well-drained dark sandy loam easily tilled and well supplied with organic matter is best. In the Southern states heavier soils may be preferred, but commercial growers state that a warm, quick soil although poor, is preferable to a heavy retentive soil even though rich. The soil must be well supplied with humus in a decomposed state. Lighter soils with southern exposures are selected for the early crops, and the heavier loams, almost clay loams, for the late crops.

Soils in irrigated areas. In California, one of the chief strawberry areas is located on a shallow loam, underlaid by hardpan. Irrigation is practiced, the proximity of the hardpan preventing the escape of the water. On light, deep loams, where irrigation is necessary, the cost of frequent applications and mulching is prohibitive. Where irrigation is practiced, a fine loam soil is preferred and the ditches are run down each side of the row. In arid regions, light loams are liable to become dry and hot to a depth of several inches in spite of cultivation. This condition often causes the dwindling, if not the death, of the plants. The remedy is irrigation or the selection of more retentive soils.

Climate. The strawberry is not a hot weather plant. In the Southern states the fruit ripens during the cool season, and in the Northern states during the early summer. In regions of limited sunshine as in Nova Scotia, the berries mature over a longer period of time and later in the season. High temperatures tax the plant's ability to transpire enough water to remain cool. When the water supply fails, the foliage either wilts or the margins of the leaves burn, or the plant succumbs to some malady due to debility. Naturally a few days of such weather reduces the yield.

Preparing the land. It is advisable to get the land in readiness two or three years before planting. Growing an intertilled crop will assist in destroying the white grub which is one of the most serious pests of this crop. Hoed crops help to destroy weeds, another pest of strawberries. Growing a clover crop for a year prior to strawberries is excellent. In the Northern states the land, if in grass, is usually prepared by deep plowing in the fall preceding the spring setting of the strawberries. It should be thoroughly worked in the spring and be thoroughly pulverized.

Manures and Fertilizers. It is best to apply manure to the crop coming before the strawberries to get rid of the weeds. Many growers also apply from 300 to 500 pounds of dried blood, or half a ton of tankage, a ton of wood ashes or 200 to 300 pounds of muriate of potash, and one-half a ton of acid phosphate or bone meal to the acre. These amounts are used to give an adequate supply of plant food. These will not give the best results unless there is a large supply of organic matter. From ten to forty loads of manure are used per acre. The application of lime is not advised. The lime in wood ashes may make them objectionable in some soils. Should it be found necessary to use nitrate of soda after the plants are growing, apply when the plants are dry, otherwise it may burn the foliage.

Rotations. In the South, where strawberry growing is a business, a rotation somewhat as follows is practiced: (1) Strawberries one or two years, the strawberries plowed under and the land sown to cowpeas. (2) Oats, or in trucking sections early vegetables followed by cowpeas or late vegetables. (3) Corn with cowpeas between the rows, the stubble plowed under and strawberries next year. In Florida, Alabama, Louisiana, Mississippi, Texas and the coastal region of Georgia, the beds are set annually, usually in September or October. A crop is secured the following January, February, March or April. The plant is an annual, having a life of six to eight months. New plants are often secured from the North, or they may be home grown. Farther north, two crops are grown before the plants are removed and in exceptional cases more. In California, the beds may last six or eight years. In the North, the rotation may be as follows: (1) Strawberries, two years. (2) Corn or some inter-tilled crop. (3) Grain crop. (4) Clover for hay, which may be manured and is followed by strawberries.

Pollination. The transportation of pollen is accomplished by bees and other insects. If these cannot work while the plants are in bloom, nubbins or partially developed fruits will result. This condition may be due also to rain, low temperatures or frost as well as to a lack of insects.

Propagation. Propagation is usually by means of runners. These are formed most freely just after the bloom is set. After taking root they are dug up and transplanted as required, in fall or spring, according to location. Varieties which do not make runners freely may be multiplied by division of the plants. Pan-American and Bush Alpine are two varieties which produce few runners. New varieties are secured by sowing seeds.

Planting systems. Usually after the ground is thoroughly fitted, it is marked out for planting. Many methods of planting are in vogue. Many look upon the matted row as the most promising commercial system. The yield may be heavy, but the fruit is usually smaller and is often not so well-ripened as that grown under other systems. The rows are made from 3 to 4 feet wide and the plants set 18 to 30 inches apart in the row, depending on the variety. The runners fill the space of 18 inches or 2 feet wide. The plants are confined to this area. In the single row system, rows are placed 2 to 3 feet apart, plants 20 to 30 inches apart in the row. The runners are straightened to form a single row of plants, surplus runners being removed.

In the double row system, the rows may be 3 feet apart and the plants 30 inches apart in the row. The runners are so placed as to give two or three rows of plants instead of one. Any runners not needed are cut off. The plants first formed are the best. This system is replacing the matted row in some places. The matted row system requires the least labor and the yield is usually greater. Under exceptional circumstances the hill system has produced heavy yields. In the hill system the plants are set 12x14 inches, or 12x18 inches apart and sometimes in rows

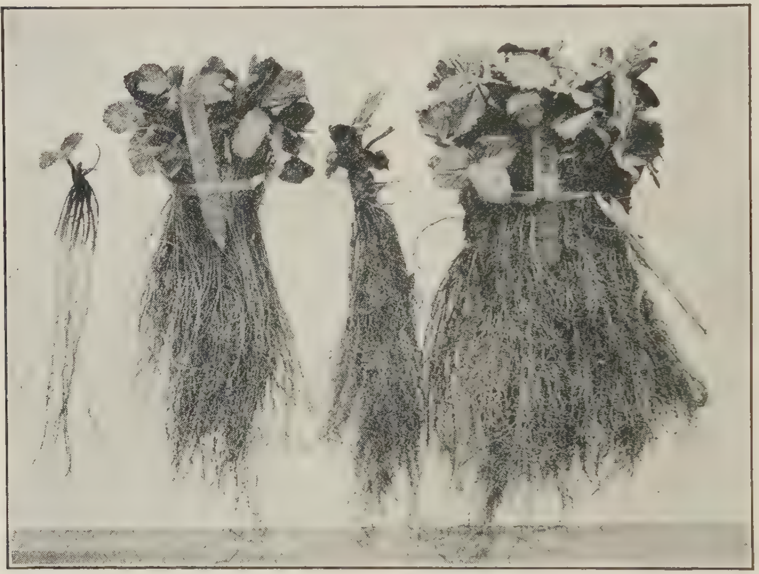

Fig. 135. Strawberry plants in bunches of 27 plants as received from the nursery, also single plants of each variety, showing the variation in size of plants due to variety. Both plants are of good size for the variety. Note variation in root systems. Other varieties show even greater variation. The facts must be known about a variety before attempting to select plants

U. S. D. A.

3 feet wide, the plants 12 inches apart in the row. No runners are allowed to form. The bed is maintained with the plants at this distance and is carefully cultivated by hand. Under exceptional conditions a bed may be retained nine to ten or more years. Under the matted row system it is allowed to produce one crop and is turned under. However, in some instances two crops are taken. In Florida, the hill system is preferred; although a smaller yield may be secured, plants set singly in rows 3 to 3½ feet apart yield a higher percentage of first-class berries.

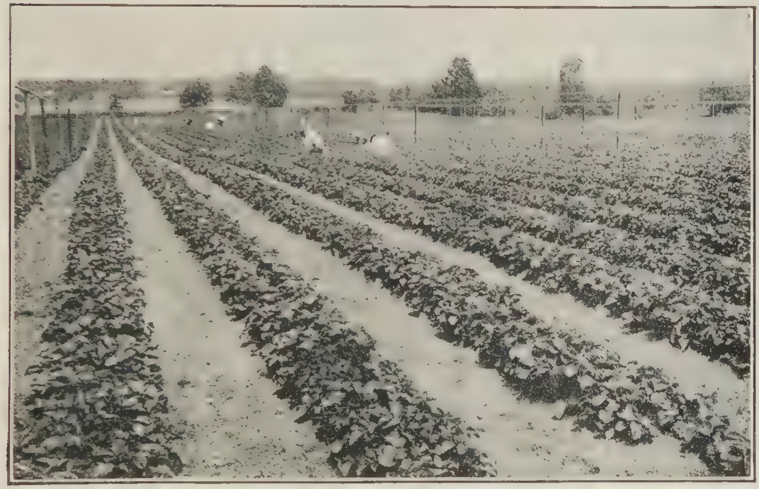

FIG. 136. Chesapeake strawberries in New Jersey, grown in hills in double rows. The rows in each pair are 8 inches apart, the plants 6 inches apart in the row. From center to center each row is 44 inches apart. Note overhead irrigation system

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Planting. The number of plants required to set an acre, rows 3½ feet apart and plants 18 inches apart, is 8,300. If the variety makes plants freely like Dunlap, 6,500 will be ample. If the plants are shipped a distance, it is important that they be moved expeditiously, so as not to rot and decay. As soon as received, the plants should be unpacked; if they cannot be planted at once trench them in singly or trench thinly in narrow rows, and thoroughly soak them so as to maintain their vigor. When planting, all dead leaves and runners are removed. Retain only two or three of the green leaves, and shorten the roots back about one-third. Keep the plants carefully covered while handling. Ten minutes' exposure on a hot windy day may destroy a plant. A narrow trench is opened and the plants set in place; a trowel or a spade may be used.

Mix the varieties. Some strawberry plants are perfect and carry staminate and pistillate flowers. They are capable, therefore, of pollenizing themselves. Other varieties are pistillate only. They are female in sex. Such flowers need a staminate or perfect variety to be planted alongside in order to furnish pollen. There is no use to plant varieties with imperfect blossoms by themselves. It is necessary to plant one row of a perfect flowered variety to every two or three of imperfect. What is still better, plant a couple of rows of each, alternately. There is a tendency to discard varieties which are imperfect. It is probable that in a few years all imperfect-flower varieties will be dropped from commercial grower's planting lists.

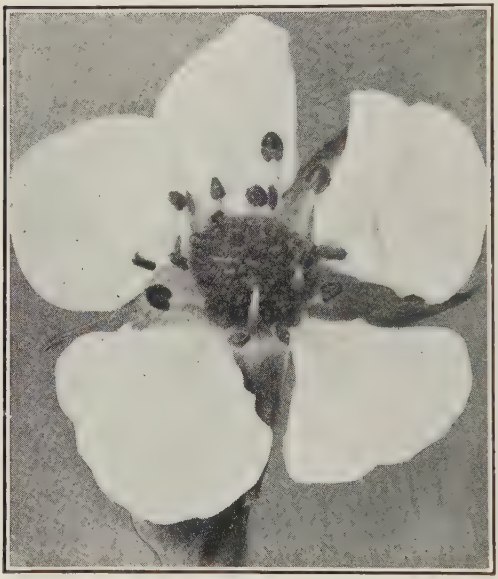

FIG. 137. A Perfect Strawberry Flower. It has stamens which furnish pollen as well as pistils, each of which connects with an ovary. These are surrounded by the white petals and the green sepals, which persist and whose function is to protect the bud

Courtesy Am. Genetic Assoc.

Planting details. In planting, the roots should be carefully spread out in the opening, not pushed into a confined space, but laid so that each root comes in contact with the soil. The soil then should be firmly pressed against them. The hand may be used to compact the soil to the roots but the heel or the foot will firm them better. The plants should neither be set so deep that the crown is covered, causing it to rot, nor be left so shallow that the roots will dry out. In the Northern and Central states planting is usually done in spring because of better weather conditions. If it is desired to plant in the fall so as to get a small crop the succeeding year, this may be done by first starting the plants in pots. Such work is too expensive for commercial use. In Florida, strawberries are planted from June to November according to conditions. On the Pacific Coast and in the states south of Virginia, Tennessee and Arkansas, the planting is usually done in the fall; in some cases from September on into the late winter. In the more northern of these areas it is delayed until early spring. In late planting no crop is allowed to develop during the first spring.

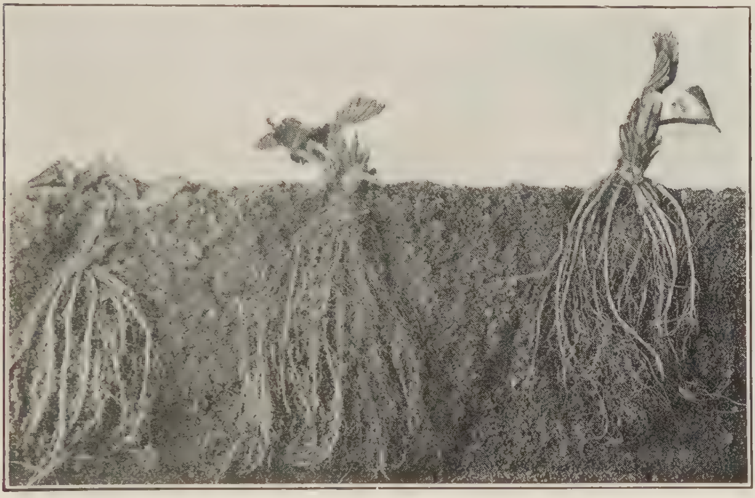

FIG. 138. Depth of planting of strawberries. Showing a plant set too deep, too shallow and proper depth in center

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Cultivation. Cultivation begins as soon as the plants are set. It should be shallow at all times and it should be constant. When the runners begin, cultivation is limited to one direction, unless the plants are maintained in hills; then the runners are cut off from time to time and not allowed to form. Cultivation is maintained throughout the season and the plants are kept free from weeds. Where the plants are grown in hills, hand cultivators are used all the time. If a bed is used for propagation of plants only, the flowers are removed as they form. Very rich peaty or muck soils are preferred.

Winter treatment. In the Central and Northern states, it is advisable to protect the plants in winter. A mulch of wheat straw, pine needles, spent hops, cut cornstalks or salt meadow hay may be applied in late fall. From Virginia and Missouri southward, mulching as a winter protection is not practiced, but litter may be spread under the plants to keep the fruits clean. Mulching is not practiced on the Pacific Coast where irrigation is used. The mulch is usually about 2 inches deep over the plants. Some growers prefer 3 to 4 inches deep. In Minnesota and the Dakotas a mulch is often used to a depth of 6 inches. Litter containing weed seeds is undesirable. Mulching is usually delayed until the ground is just frozen. The covering should be sufficient to cover the crown of the plants. The mulch is helpful for several reasons, as follows:

(a) It protects the roots against repeated freezing and thawing and tends to hold the moisture in the ground for the following spring.

(b) It is particularly useful in regions where there is considerable freezing and thawing and little snow covering. If strawy manure is used, considerable fertilizer value is added, and even the straw itself puts the land in much better physical condition.

(c) The growth in spring is retarded a little so that the danger from late spring frost is reduced.

Neglect of the strawberry plant in the fall and early winter reduces the yield, for the treatment given in the fall determines the number of flowers which will develop and the number of pistils each flower will produce. Flowers with a large number of pistils make large fruits, those with few pistils produce culls.

Spring treatment. As soon as the plants start in spring, the mulch is drawn back and left between the rows to keep the fruit clean. If the weeds start, the rows are cultivated, the mulch being lifted to let the cultivator go by or it is hauled off and saved for use another year. A little of the mulch is usually left all around the plants to aid in keeping the fruit clean, but good strong plants with strong stalks will keep the fruits off the ground.

Fall-bearing varieties. There are several fall-bearing varieties which tend to bloom continuously from the early summer to late fall. To make sure of a late crop, it is advisable to pick off the first blossoms until the middle of July. This tends to increase the crop later in the season. These varieties are of value for home use, but is is questionable whether they are of commercial value except to those engaged in selling plants. Anyone desiring strawberries up to October can certainly get them in this way, and it will depend upon the market whether there is any profit in the business.

Forcing strawberries. Early berries may be grown in the greenhouse. The first runners as formed are chosen and they are grown in small pots, later transplanted into 6-inch pots and held in a cold frame from October to January. Usually the pots are packed in coal ashes. From January to February they may be put into the forcing-house and liberally watered with liquid cow manure. The blossoms should be hand-pollenized if no insects are present. Each pot may be allowed to set six to eight fruits and these will mature in from eight to twelve weeks after starting growth.

Overhead irrigation. Some growers in the East use the overhead system of irrigation by which they produce artificial rain all over the patch. Where one has a convenient supply of water it is profitable for truck crops and may be used on the strawberry plants.

Insects. The Strawberry Crown Borer (*Tyloderma fragaria*). The grub burrows into the crown and may destroy it. Rotation of crop is advised for this and the following.

The Crown Girdler (*Otiorhynchus ovatus*). The grubs feed on the roots of the strawberry, white clover and some grass plants. Both of the above insects are wingless, hence damage is local.

Strawberry Root Louse (*Aphis forbesi*). Secure plants from clean beds and avoid the trouble. If present treat with nicotine sprays.

The White Grub (*Lachnosterna spp.*) is the larva of the June bug or May beetle. It eats the roots and crowns of the strawberry plant, and if it is present there is no use planting strawberries. Control is to work the land for two or three years prior to planting.

Tarnished plant bug (*Lygus pratensis*). These insects sometimes puncture the young strawberries, causing "nubbins." Give clean cultivation.

Strawberry weevil (*Anthonomus signatus*) lays its eggs in the flower buds. When these hatch, the grubs eat away part of the stem below the bud, causing it to droop. The grubs feed on the pollen of the flower bud and for that reason the imperfect flowered kinds are not attacked. Dusting with sulphur 85 per cent and arsenate of lead 15 per cent at the rate of 75 pounds per acre partly controls the weevils. Three dustings at weekly intervals may be necessary.

Leaf roller (*Ancylis comptana*) is a small brownish caterpillar which rolls the leaf. Spraying with arsenate of lead, 3 pounds to 50 gallons, or dusting as soon as it appears will tend to control the first brood. Mowing the beds and burning the foliage will destroy many of the insects as well as many of the strawberry weevils. If the bed is not to be kept, it should be plowed under.

Strawberry root worms. The parents feed on the foliage and may be controlled by spraying with arsenate of lead.

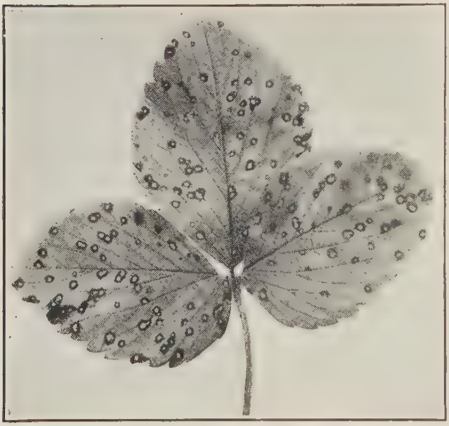

FIG. 139. Strawberry Leaf-spot

Ground beetles (*Harpalus caliginosus* and *H. pennsylvanicus*) sometimes attack and eat the seeds and fruit.

The proper rotation of crops, plowing under the bed at the end of one or at the most two years, and thorough cultivation of the land for the succeeding year, as by growing an inter-tilled crop, will tend to control these insects and in fact almost all.

Diseases. The leaf-spot (*Mycosphærella fragariæ*) causes the familiar spotting on the foliage. It is usually advised to spray thoroughly with bordeaux mixture, 3:3:50. Some growers question its value. Varieties vary in their susceptibility to it, and good air and soil drainage tend to reduce it. It is better to avoid these diseases rather than attempt to cure them.

Powdery Mildew (*Sphærotheca humuli*) is a fungus disease which appears on the surface of the leaves as a whitish mold and causes them to curl. Spraying with the bordeaux mixture will sometimes aid in controlling it, but if it is very serious, potassium sulphide, one ounce to two gallons of water, is more efficient.

Leaky strawberries—black mold (*Rhizopus sp.*). A black mold sometimes develops on the fruits. It appears as small white hairlike threads, each of which bears a round black head. The contents of the boxes so attacked shrink to a half or quarter of their normal size. This is a transportation problem. It cannot develop if the temperature of the load be held below 45° F.

Gray mold (*Botrytis sp.*). A small tan-colored mold appears on the surface of the fruit, which turns brownish gray. This does not cause the fruit to break down unless other rots are present. It attacks green as well as ripe fruit, appears to be of field origin, and causes serious losses in shipment.

Patellina rot appears on the fruit as a sunken tan-colored spot in which the diseased area is sharply marked off from sound fruit. The fungus fruits on this diseased area. This is a field disease and causes loss in shipments.

Origin of the diseases. It is claimed that most rots except "Leak" have their origin in the field or the packing-shed. Piles of rotting fruit may furnish the infection in some cases. The remedies are as follows: (1) Have fruit harvested on time. (2) Put fruit under cover as soon as picked. (3) Discard all ripe berries and those showing bruises or rot. (4) Wet fruit is more apt to rot than dry fruit, although washing fruit has been suggested as a means of cooling it. (5) Precool all fruit at once. (6) Don't hold cull fruit over from one day to another in the packing-shed. (7) Haul fruit on a spring-wagon, protected from the sun. (8) Bury any rotten fruit.

Harvesting. The fruit is ready to harvest as soon as it is of good color and size. If picked too green the fruit will shrivel. It must not be over-ripe or it will not ship. It must not be bruised. It must be picked by the stem and the hull or calyx must be attached to each berry. It must not be picked while wet. It should be cooled as soon as possible after it is picked and should be handled as little as possible. As one goes South, the harvesting season extends. In Florida and Louisiana and the Gulf Coast region, harvesting may last from January or February to June, a period of five months. In South Central Alabama, the period may run from April 1 to July 1, or three months; in Northern Alabama, the duration may be but six weeks, while in New York the picking season on the same bed may be but two to three weeks. On the Pacific Coast in California, with irrigation to tide the plants over the hot time, there are regions where the fruiting period lasts nine months or even longer; further north in Oregon and Washington, the longer winter reduces the period of production.

The introduction of the fall-bearing varieties extends the season during which one may furnish strawberries from their own garden, so that in New York and southward they may be gathered from June to October, or four months.

Grading. In many cases, the fruit is graded as picked, by the pickers. They usually have trays which hold four or eight quart-baskets and the different sizes of fruit are put in these as harvested. Field grading ensures very little handling, but demands close field supervision. Its success depends largely upon the organization of the force and destination of the fruit. Some growers grade by pouring the fruit from one box to another, removing the culls in the process; others merely remove the culls or defective fruits from the top layers of the box before placing them in the delivery crate.

Pan grading. In the Ozark berry region, pan grading is practiced. Each field-run box is emptied into a pan, from which all undesirable fruit is removed, and that which is satisfactory is returned to the box without handling. It saves touching the fruit. Its success depends upon:

1. The variety. Firm varieties as Aroma are easily handled. With tender varieties or fully ripe fruit, the damage incurred in rehandling offsets all gain.

2. Labor supply. This must be abundant and the force doing the work must know how to do it efficiently, and economically.

3. Returns. The pan-graded product must sell for a sufficiently increased price to cover the various items of cost as loss in bulk due to discarding culls, cost of sorting, cost of handling packages twice, etc.

Packages. The boxes, baskets, cups or tills used for interstate shipments must be of one quart or one pint capacity, dry measure. The capacity is 33.6 cubic inches for the pint and 67.2 cubic inches for the quart. Special size boxes may be used for local trade if desired. The boxes should be well made. Those of very thin veneer do not stand up in transit. Ventilated wooden crates holding 24 or 32 quart boxes are in most common use. The 36-, 48- and 60-quart sizes also are used. The size of each crate must be marked thereon as "Min. Vol. 24 quarts." Many special crates are in use in various parts of the country. The crates generally in use in the East have a cover fastened by means of hinges and a catch. This arrangement permits of inspection with a minimum of work. The layers of boxes are separated by thin wooden dividers. New, clean, well-made crates are best. A second-hand, soiled crate will injure the sale of the fruit on the open market. They may be used when shipping to a canner where the sale has already been made.

Packing. The boxes must be full, not so full that they will crush nor yet be slack. Slack packs are as hard to sell as over-ripes. The boxes must be free from trash, leaves, sticks, etc. Facing or the placing of the best fruits on their side on the top layer of the box is often practiced. It is satisfactory provided the rest of the fruit in the box is up to the grade sold. Topping, or the placing of a better lot of fruit in the top tier of boxes in a crate than is found in the bottom tier, is bad practice.

Packing-sheds are often temporary shacks or tents erected at convenient intervals in the field. They should be so placed that the pickers have a minimum walk when bringing in the fruit. On a large plantation these may be merely receiving stations, and a more pretentious packing-shed of a permanent nature be situated elsewhere. These sheds should have perfect and free circulation of air and give ample shade to the full crates and workers.

Pony refrigerators. The southern crop when shipped by express in less than carlots is often sent in small refrigerator boxes. These hold 64 or 80 quarts of fruit, are heavily made with air-tight covers clamped in place. Inside is a metal-lined compartment or tray for the ice. The ice tray used in California is located on the side. More often it is placed on top in the Florida package. These packages are returned to the owner.

Loading cars. All crates should be loaded so as to receive the benefit of a proper circulation of air. Floor racks in the car are essential. Spaces should be left between the crates. All crates must be braced. Sometimes this consists of merely pushing the crates against each other and letting them go, which is risky. They should be firmly pushed into place and the braces put in place between the doors to hold the load from moving. On short hauls this is not necessary, especially if the fruit is sold to a canner, but where the fruit is marketed on arrival at destination, the greatest care must be taken in the loading of all berries.

Yields. Various sets of figures indicate an average production of 1,771 quarts per acre. Considering only well cared for beds it is safe to assume that the average yield is probably about 3,000 quarts per acre, but under favorable conditions may reach 9,000 quarts. There are records of 25,000 to 40,000 quarts per acre under intensive cultivation. In California, where the season for harvesting may extend from six to eight months, yields of 10,000 to 15,000 quarts are common.

Refrigeration. The fruit, even when handled in the best manner possible, should be consumed within ten days after harvested. It is not advisable to attempt to hold strawberries long in cold storage unless frozen. They may be held a few days at 40 to 50° F. to prevent deterioration.

As long ago as 1872, Parker Earle, of Cobden, Ill., precooled his shipment of strawberries to 50° F. before loading same for shipment and made his first successful carlot shipment to Chicago. At that time Parker Earle was one of the largest strawberry growers of the country. He developed the idea of using refrigerator cars for the movement of fruits, and was the first to precool the fruit previous to shipment, and thus became the father of the carlot system of transportation of perishable fruits. His first carlot shipment was made in 1868, another in 1869, both of which were failures. He was the first to ship strawberries in iced refrigerators or boxes by express as the early southern fruit is now moved. His first shipment was made in 1866. Some day we shall appreciate what he did for the fruit industry.

Cost of growing strawberries. The cost of growing an acre varies with different men and different conditions. In one case in New York the pre-war cost of operating to harvest is given as follows: Labor at 15 cents per hour and horse labor about 12.5 cents per hour.

Rent of land, two years	$ 11
Plowing and fitting	6
Plants	15
Setting plants	4
Cultivation	16
Straw for winter and fruiting mulch	15
Labor, hoeing, pulling weeds, etc.	10
	$ 77

Another grower gave the following costs:

Interest and taxes	$ 15
Plowing, harrowing, surface-draining	5
Value of 11,000 plants, $5 per M	55
Manure, 60 loads at $1 per load	60
Marking ground and setting plants	4
Summer cultivation	8
Training runners around plants	3
Winter covering and cost of putting on	6
Taking off winter cover, and spring cultivation	5
	$161

The latter secured a yield of 7,136 quarts per acre in an unfavorable year when fruit sold at 12 cents per quart. His gross receipts are given as $500. Cost of growing the crop, $161; cost of picking, crating and marketing 7,136 quarts, $157; available for labor income of operator, interest, etc., $182.

In one instance the cost of production of strawberries in Florida during the same period as above, was:

Interest on investment and land	$ 20
Interest on equipment	10
Preparation of land	10
Fertilizer	40
Plants	40
Setting plants	5
Cultivation	10
Picking 3,000 quarts at 2½ cents	75
Grading and packing at 1 cent	30
100 crates at 15 cents each	15
3,000 boxes	11
Hauling to station	10
	$276

Cost per quart 9.2 cents f.o.b. cars Florida. In Southern California, one grower gave the cost of producing and marketing a pint of strawberries as 3½ cents and the average selling price as 5 cents. The costs in the South varied from $76 to $142 per acre for growing the crop of fruit; $65 to $105 for picking and packing, or a total of $141 to $247 per acre. The yield was 2,000 quarts.

PART VIII

MISCELLANEOUS

CHAPTER XLVIII

THE PERSIMMON

The native persimmon (*Diospyros virginiana*) is one of our neglected fruits. It grows wild over the southeastern quarter of the country, and as far north as Eastern Kansas, Southern Ohio and Southern Connecticut. The tree varies in size from a shrub to a tree 50 or more feet high. There is marked difference among the plants in many characters. It comes in bloom in May and June and has wax-like flowers which fill the air with their fragrance. It bears a pale orange or yellowish fruit which changes to a dull red when ripe. These hanging among the dark green, glossy leaves make the tree quite ornamental. The fruit is generally astringent until ripe. It varies in size from one-half inch to 2 inches in diameter, and usually contains seeds but occasionally not. As an ornamental tree it compares favorably with any other shade tree, but it should not overhang a walk on account of the dropping fruit.

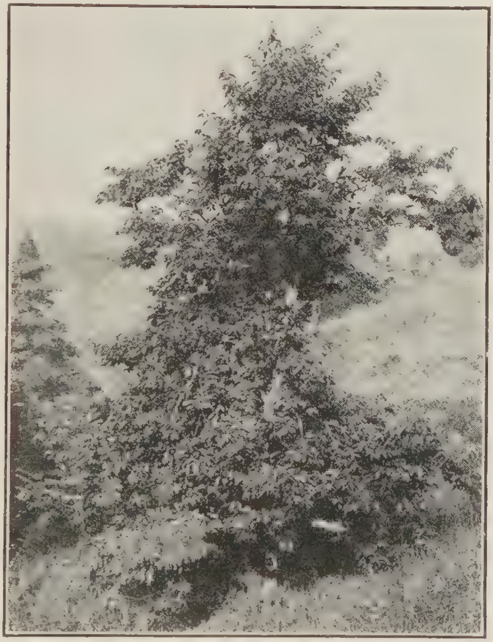

FIG. 140. A Native Persimmon Tree of upright habit of growth. Worthy of consideration for planting for decorative effect. Other varieties have a drooping habit *U. S. D. A.*

Soil. The persimmon grows on sandy, clay, stony and rocky soils and even in muck land where water stands part of the year.

It prefers to be in the open field or wood where it can secure ample sunshine.

Propagation. Varieties can be propagated by budding or grafting any time when the bark will open freely, but to facilitate union it is important that the cut surface be closed tightly to exclude the air. Scions or buds should be from trees which have fruited. Some trees bear male blossoms only. The seedlings should be handled as outlined in Japanese Persimmon. Owing to the large tap root the tree does not transplant well. Sprouts from the root may be used for multiplying a desirable native variety.

Planting. The trees are planted 16 to 20 feet apart each way and may be kept headed low so that the fruit may be easily harvested. If the fruit is not hand-picked, the trees may be planted closer. Intercrops may be grown between the trees for the first year or two if desired.

Handling the fruit. The fruit as grown in Indiana contains 35 per cent solids, of which 31.74 per cent is sugar. No other fruit of the temperate zone exceeds it in food value. It is usually grown for feeding hogs, but the finer varieties are of use for human food. Fruits of the oblong type may cure on the tree like dates and will hang for several weeks. The fruit is usually shipped in quart boxes in a strawberry crate. For storage purposes the largest fruits should be packed in egg crates or in single layer flats, the fruits being held separate, and this is probably the best way for shipping the best fruits. Such fruits must be harvested with care while still hard ripe, but just as they are beginning to soften.

THE MULBERRY

Mulberry. The Chinese have cultivated the Mulberry (*Morus spp.*) from time immemorial as food for the silkworm. The industry has developed to some extent in Southern Europe. Mulberries are found native in all parts of the globe with the exception of Australia. The leaves are grown largely for feeding silkworms, but in Europe the fruit is grown for eating out of hand, as dessert, and for the manufacture of wine and syrups. Whatever is not used in this way may be fed to pigs and poultry. The fruit is a very sweet berry, somewhat like a blackberry in appearance. Some fruits are small, others as large as the largest blackberry. They are of various colors, white, black, red and shades in between. The fruit is soft and easily injured. It cannot be shipped. It is not known on our markets.

Mulberries are of interest because of their remarkable variability; even the leaves on the same tree vary in shape, and some of them are of distinct decorative worth. The custom of sowing the seed as a means of propagation has increased the number of forms since the seeds do not reproduce the parent. Some trees show the cut-leaved foliage. In 1883, Teas' Weeping Mulberry occurred as a seedling of the Russian Mulberry. It will not reproduce itself from seed, hence it is propagated by grafting on the trunk of a straight growing Russian tree, at a point several feet from the ground.

Groups of Mulberry. Bailey classifies the various mulberries in the following groups: (1) White Mulberry (*Morus alba*), of which there are various divisions (a) Russian (*Tartarica*), (b) Nervosa (*Venosa*), (c) Multicaulis type; (2) Black mulberry (*Morus nigra*), and (3) Red or native group (*Morus rubra*). The most common of these various divisions are the white, black, red and the paper mulberry.

The White Mulberry in some form, is the most common in the eastern portion of the United States. The Russian mulberries make small trees. They are hardy and have been planted in the Western states for windbreaks and for hedging. Some of the white mulberries (the group to which the Russian mulberries belong) make a tree 2 feet in thickness. The original variety, Downing, belonged to this Multicaulis group. The variety New American, another white mulberry, is the one usually sold for Downing. Among other varieties suitable for the North and Eastern states are Thorburn and Trowbridge. The white mulberries are used in China to furnish the leaves for the silkworm.

Black Mulberries are not as hardy as the white. They need some protection as far north as New York, but they may be grown in the Southern states and on the Pacific Coast. This type is most commonly grown in Europe for fruit. Black Persian is one of the most common varieties.

Native Red Mulberry is the giant of the group. Trees may attain a height of 70 feet and a thickness of 3 to 4 feet in the Southern states. They are found growing on rich soils and bottom lands. The leaves are of no value for feeding silkworms. The varieties Hicks and Stubbs are used for planting in hog pastures.

Paper Mulberry is found growing in Asia, also in Europe even in the northern portions. Much of the paper used in Japan and in the East Indies is made from the annual shoots of this tree.

Propagation. The stock is usually a seedling of the ordinary white mulberry. On account of its ability to withstand cold and drought, even the rigors of a winter in the Central Northwestern states, the Russian mulberry seedlings are used in many portions of the country. This Russian type is used for some of the dwarf trees. In some parts of Europe, especially in the warmer portions the ordinary shield bud may be put in early in April as soon as the sap begins to flow and the bark will lift. Bud sticks should be cut in late fall or early winter and packed away in damp sand or held in cold storage until needed.

Grafting. The grafting or budding of mulberries is not usually successful by the ordinary means of grafting or budding. Some of the cut-leaved and variegated-leaved types which are used for decorative purposes and for shrubbery are propagated by grafting. They will not reproduce from seed. Flute grafting is usually practiced. The work is done in April. It is similar to the method of propagating nuts. A two-bladed knife is used to cut around the stock and the bud stick. The piece of bark carrying the bud is carefully taken off the bud stick and placed in position on the stock; both being cut with the same knife, they fit tightly in place. Should the bud and its bark not fill the whole of the circumference, a small piece of bark may be inserted to cover the wood. It is advisable to place the flute bud immediately under a bud of the stock, for in this way a more rapid growth is encouraged. The bud is carefully tied into place and must be watched for a few days to make sure that the string is not cutting in. In some cases a mastic of grafting wax or paraffin is applied to the cut surface to aid the graft. In doing this and in tying the bud, care must be taken not to cover the bud itself. The work may be done any time during early spring or early summer when the bark will peel and while the sap is moving. If the stock is but one year old, the bark will work better than on older wood. The scions are to be of the current year's growth, showing well-formed buds.

Willard method. By the method of graftage employed by the late S. D. Willard, of Geneva, N. Y., the grafts were secured in fall and held dormant until spring. As soon as sap is moving and the stocks will open, grafts containing two or three buds are cut with a long, tapering cut, at the butt end. An incision is made in the stock as for shield budding and the graft is inserted, tied in place and waxed. The grafts must be held dormant, preferably in cold storage.

Grafting by approach. There are several ways of doing this, but in a general way, the operation consists of taking a branch of the growing tree and placing it in union with the trunk or branches of the stock, in such a manner that the cambium layers of both are in contact For instance, a piece of the bark may be removed from both and the cut surfaces tied together so that the cambium layers touch. They are then tied in place and waxed and the stock is staked so that the wind will not move it. If this is done in time, while the sap is flowing rapidly—say from April to August—a union may be effected. When it is made, the top of the stock is removed and the scion is severed from its tree. Sometimes it is wise to allow a scion to make a year's growth before severing it from its parent.

European custom. In European nurseries, trees to be used for approach grafting are planted in pots so that they may be used for several stocks, or they may be planted near the stock to be grafted. The English custom is to make an incision in both the graft and the scion like a whip graft, so that they are held together by the wood until a union is perfected.

Soil. Mulberry trees are found growing on rocky ledges and gravelly soils, but they do better on richer soils.

Planting. Trees are usually planted 20 to 40 feet apart, depending considerably on the kind grown. The trees may attain a height of 20 to 30 feet. They have round, open heads. If grown under particularly favorable conditions they may make larger trees. Two or three trees may be planted on each farm and whatever fruit is not used by the family or locally, may be fed to pigs or poultry. They are sometimes planted in cherry orchards for the birds.

Harvesting. The fruit is usually shaken off the tree onto a sheet or straw laid under the tree. In Europe the land is usually in grass and it is cut closely and the fruit picked up as it falls. Ripening extends over a period of several weeks. It is customary to give the tree a slight jar to shake off the ripe fruit. The fruit is eaten out of hand as dessert, being esteemed by some on account of its flavor. It has a laxative tendency. It may be made into wine. A syrup made from the unripe fruits is sometimes used as a gargle for sore throats.

THE BARBERRY

The common barberry (*Berberis vulgaris*) is usually grown more as an ornament than for its fruit, although it is cultivated to make jelly, preserves and sometimes pickles. The plant when propagated for fruit is quite productive. There is only a limited demand for the fruits. Barberry plants act as host for the rust which attacks wheat, hence it is proposed to eradicate this plant wherever wheat growing is of importance. The Dwarf Japanese barberry is not susceptible to the disease.

THE BUFFALO BERRY

Buffalo berry (*Shepherdia argentea*) is a thorny shrub which grows anywhere from 5 to 20 feet tall. It is sparingly cultivated for its fruit, which is usually round or roundish and scarlet or yellow in color with a single smooth seed, and acid agreeable flavor. The berries ripen during July but hang on until frost. The plant occurs throughout the Plains region southward to New Mexico, where the plant undoubtedly has a place in cultivation. It has been cultivated in Massachusetts in a small way and was introduced to agriculture in the East before the blackberry or black raspberry, but unlike these two plants, it has failed to make any headway. The berries are usually about the size of currants, but on some plants they are as large as small gooseberries. It is usually found growing along the banks of streams and prefers loose, dry, sandy land with a good moisture supply below.

It is propagated from layers, suckers, cuttings or seeds. The cuttings may be handled like grape or currant cuttings. Some of the plants are staminate, others pistillate. It is necessary to be sure that both sexes are present. In the pistillate plants the buds are smaller and more slender and can be readily detected without waiting for the plants to come into bloom. The plants are grown as ornamental shrubs, the silvery foliage making them distinct and attractive. The fruit may be eaten out of hand or it may be dried and kept indefinitely. Frost does not hurt it and it may be gathered during winter as needed unless the birds take it first. It makes a very good jelly.

THE ELDERBERRY

Elderberry (*Sambucus spp.*). In certain regions there is considerable call for the fruit of the elderberry, for pies and wine. In the Central West they take the place of the huckleberry in pie-making. The plants can be easily cultivated. They are hardy, usually grown in a corner of the yard or garden and a few bushes will supply a family. The aim has been to find plants in which the fruit contains very few seeds and the heads are large. The Adams Improved variety bears fruit one-quarter of an inch in diameter. A single head has been grown 20 inches in diameter and when shelled was found to contain 1¼ quarts of fruit. The Brainard, introduced in 1890 by Brandt, has fruit about three times the size of the wild form. Superb—a new and excellent cooking variety—was originated by Luther Burbank, and there are many others. Not very much care is necessary in the management of the bushes. Some plants readily maintain a tree form. New canes are brought in from time to time, cutting out the old ones, and a sufficient amount of bearing wood should be maintained in the bush. The fruit ripens in August or September. The plant is readily propagated by hardwood and greenwood cuttings or pieces of roots and from seeds. The Common European Elder (*Sambucus nigra*), is protected to a degree in Great Britain. Its fruit is used in wine-making. A rich soil well supplied with moisture is best, but the plants will thrive on any good soil. The plants will respond to good care and treatment, but very little headway has been made in their commercial production.

THE GOUMI

The Goumi (*Elæagnus longpipes*) is a low bushy shrub, the leaves of which are green above and silvery beneath and dotted with dark-colored spots. The blossoms appear about the middle of May and the fruit ripens in July. It is very disagreeable in taste at first, but this disappears when the fruit is thoroughly ripe. The fruits are about one-half inch in length and of red or orange color, covered with silvery white dots. The fruit when cooked can be made into a sauce which is eaten with meat or chicken, especially chicken. It is also recommended for jelly. The plant is hardy in the Eastern states and is productive. It may be propagated from seeds or from cuttings made in June or July. Besides being an ornamental shrub, the fruit is attractive and is worthy of more attention.

THE HAWTHORN

Hawthorn. Luther Burbank sent out the Chinese Fruiting, a small tree which bears bright crimson fruits of the size of large olives which are excellent for jams, jellies, etc. The foliage is attractive in the fall.

THE JUNEBERRY

Juneberry (*Amelanchier spp.*). At least four plants are classed under this name. There is the Shad Bush Juneberry which grows quite tall, up to 40 feet. The Dwarf Juneberry grows from 2 to 5 feet and is one of the most promising forms for cultivation; to this group belongs the variety known as Success. The Northern Dwarf Juneberry grows 2 to 4 feet tall and bears large dark purple or reddish purple fruit. The Western Service Berry or Shad Bush is a low shrub a few feet tall and thrives throughout the Central West. It bears dark blue nearly black, sweet, juicy fruit one-half inch to 1 inch in diameter and ripens from June to September.

Juneberries are receiving more attention from nurserymen now than in the past, many firms cataloging them. They have been sold as huckleberries throughout the Central West. It is doubtful whether the fruit will make much headway where currants, cherries and gooseberries are grown successfully, but on account of the hardiness of the plant, it will probably find a place in the home grounds, although it is not likely to become a commercial crop. Birds are very fond of the fruit, and it is worthy of consideration on this account alone. The dwarf types are the more productive. The plants can be propagated from seeds or from sprouts taken from the base of the plant. There are several named varieties on the market and more may be expected.

THE MEDLAR

Medlar (*Mespilus germanica*). People born in Europe know this fruit better than the American born. The small tree or bush grows 10 to 15 feet high. It is quite hardy. It bears soft, luxuriant foliage, and white blooms in late May or early June. The fruit is harvested after a frost and stored in a cool, dry room to ripen. When soft, it turns brown and may be eaten or made into preserves. Seedlings are raised much like hawthorn seedlings are grown, and these may be used as stocks, or quince or pear stocks may be used. The stocks may be budded or grafted. Dutch or Hollandish bears fruits about 2½ inches diameter. Nottingham is smaller and of better quality. There are other varieties including a seedless one.

THE PAWPAW

The pawpaw (*Asimina triloba*) is one of our neglected fruits. The plant grows wild from New York to Mississippi, and West to the Mississippi River. Trees have been known to bear for sixty to seventy years and probably live longer. The tree is excellent for planting on the lawn. If the fruits are thinned to one in a cluster and properly mature, not only is the plant ornamental but it is also useful. The largest tree known grows near Boomville, Warren County, Indiana, and is 6 feet 6 inches in circumference at the base and 25 feet high. The plants thrive best on a well-drained soil which can hardly be too rich.

There is marked variation in the fruit borne by individual trees. The best fruits are large and meaty, with a mild flavor and a characteristic aroma. The flesh may be white or yellow. Eaten with sugar and cream, they constitute one of the richest of our temperate-zone dishes. Some specimens weigh 1 pound and a good tree will bear from 50 to 100 fruits every year, beginning when three or four years set. No attention has yet been given to the fruit, and it may be reasonably inferred that considerable progress can be made.

Ordinarily, the plants appear as bushes and in clumps. They are propagated by means of suckers from the roots, but individuals thus crowded do not bear such fine fruit. The seeds are quite slow in growing, sometimes not appearing for a year; after this they grow rapidly and may be transplanted when 12 to 18 inches tall, preferably when dormant, although if lifted with a ball they can be planted any time. Varieties can be propagated by grafting early in spring. The fruit should be harvested before it is fully ripe and allowed to mature indoors. It has usually been allowed to become over-ripe before using.

PART IX

THE SUB-TROPICAL AND TROPICAL FRUITS CONDITIONS AND MODES OF PROPAGATION

CHAPTER XLIX

SUB-TROPICAL AND TROPICAL FRUITS—CONDITIONS

Temperature is a vital factor in the life of all plants. There are a maximum, minimum and optimum for each, which determine or at least affect their rate of growth and life. In the temperate zone of North America we have a range of from minus 50 to 120° F. or a variation of 170° F. during the year. The average annual range of Miles City, Montana, is 140° F. In 1893 the minimum temperature was minus 45° F. on February 1 and a maximum of 107° F. on July 25. a range of 152° F. in six months. This is perhaps the extreme representative of continental climate. In the tropics at sea level the range of variation is rarely over 15° F., or from 75 to 90° F., while at Havre, Montana, on January 22, 1907, a "chinook" wind caused a rise in temperature of 38° F. in thirty minutes. Looked at in this way the so-called tropics are the temperate zone and the so-called temperate zones are decidedly intemperate.

Elevation affects temperature everywhere. The mean temperature falls 4° F. for each 1,000 feet elevation. At the Equator frost does not occur under 18,000 feet elevation. Bogota, Columbia, at a high elevation, has an average daily temperature of 60° F. the year round.

Tropics. On the map the tropical zone is an area extending 23½ degrees north and south of the Equator. Practically the tropics extend to the isotherm of 68° F. for the coldest month of the year or an area about 30 degrees wide in America and Western Africa. In the tropics sudden and violent fluctuations of temperature are impossible. Honolulu has an equable climate, the lowest recorded temperature being 52° F. and the highest 89° F. In Colombo the daily range of temperature is but 11° F. Cairo, Egypt, has a mean winter temperature of 56° F. and a mean summer temperature of 83° F.

The sub-tropics, or part of the so-called temperate zones, are the areas of the greatest range in temperature. In Jacobabad, India, which is not in the tropical zone, a temperature of 127° F. has been recorded. In January, 1893, San Diego, California thermometers registered 25° F., and in September of the same year registered 110° F., both records for forty years, but the latter does not equal the record in Death Valley. At Death Valley the official weather bureau thermometer registered 134° F. on July 10, 1913. On January 1, 1885, at Popular River in Northeast Montana, the temperature went to minus 63° F. At Havre, Montana, the temperature stood at minus 57° F. in January 1916 for a considerable time. In many places in the United States there is a range of 120° F. between the highest and lowest point of temperature.

Effect of winds. The winds have a marked effect on vegetation in the tropics. The trade winds are dry and cooling and tend to lower the temperature of the plants by encouraging rapid transpiration of water. Other winds bring rain and lassitude and inertia to the population and decidedly affect the vegetation. Winds are important agents. The clearing of the forests in the tropics makes the climate drier and warmer. The removal of undergrowth enables the wind to begin to blow the soil and wind erosion sets in.

Vegetation was removed on part of the Island of Kahoolawe and now the dust cloud is seen seventy miles away; erosion has gone so far that in some places 200 feet deep of the earth's surface has been blown away. On Lanai, the soil has been carried away to a depth of fifty feet. The power of the wind is seen in the tropics.

Rainfall. The tropics are not temperate in the matter of rainfall. Singapore has an average rainfall of 94 inches, Manila, 75, Habana 52, the Kamerun district 350 and part of Assam 458, with a maximum of 905 inches in one year at one station. The highest rainfall recorded in the United States was at Glenora, Oregon, with an average of 130 inches, and a maximum of 167 inches in 1896 and 50 inches in the month of November, 1909. The North Pacific Coast with 100 inches is closely followed by the southern slope of the Blue Ridge Mountains close to the boundary of Georgia—North Carolina with an average at Rockhouse of 82 inches. From this we tail off to 3 to 4 inches a year at Yuma and El Paso and 2 inches or less in southeastern California. The rainfall determines the practice of the plant-grower. In Hawaii the rainfall at one point was 360 inches while 28 miles away it was but 6 inches the same year. Tropical jungles and a desert growing cacti were side by side.

A tropical plant is one which will not long endure a temperature below 60° F. and will not grow where the temperature falls much below 40° F. The coconut is a good example. In some places a temperature of 65° F. with a high wind during the period of active growth will check the growth of a tropical plant. This is true of plants in the temperate zones. The results of such a condition are often seen in the case of fruits. There are many plants found growing in the tropics which can be acclimated in the sub-tropics as oranges and lemons and such are known as sub-tropical fruits. There are other plants which will not grow outside of the tropics as cacao, rubber, etc.

Reproductive period affected by conditions. Plants which bear at all periods of the year in the tropics have a restricted bearing period when taken into the temperate zones. Thus bananas and papayas have ripe fruit at all seasons in the tropics, but not so when taken away. Apples and peaches when they have been grown in the tropics at sea level have ripe fruit on the trees at all times. On peach trees in Ceylon one may see buds, flowers, young peaches and ripe peaches on the same tree at one time. There is no definite fruiting period and the same is true of apples. With cherries this does not seem to be true. The trees become evergreen and cease to bloom. Many of our temperate zone plants behave in this way when moved into the tropics.

Wood growth in the tropics. The trunks of the trees do not show the annual rings so characteristic of trees in the temperate zones, because growth takes place more or less continuously. However, there are periods when the plant is less active than at other times, during which it can be transplanted.

Tropical soils. The soils in the tropics are markedly different from those in the temperate zones: chemical activity proceeds at a more rapid rate under the stimulus of heat. Disintegration of rocks is relatively rapid. Soils of volcanic origin undergo rapid change. Leaching proceeds rapidly. The humus content is high but is rapidly decomposed. The maintenance of organic matter is one of the chief problems in cultivated soils. The iron content of the soil is often high. In Hawaii it runs 10 to 45 per cent, usually 20 per cent; in India 2 to 48 per cent. Naturally such soils are very heavy to plow and are easily puddled. The potash content of the cinders from volcanos may be high.

Laterite soils. The so-called "laterite" soils of the tropics are very heavy and are easily puddled. They may be called clay soils but this does not mean that they contain silicates of alumina like the clay soils of the more northern regions, but that they bake and crack and puddle somewhat like the clay soils of the North. They cannot be made into bricks, for when plowed in great chunks these rapidly weather away. These soils have a high hygroscopic moisture content, often up to 24 per cent. Dynamite has been used successfully in breaking up some of these soils. The purpose is to permit of better aeration for without air the amount of nitrogen in the form of nitrates in the soil is quite low. Deep plowing is resorted to in order to secure better aeration.

Windbreaks in the tropics. In the temperate regions there is a question about the wisdom of windbreaks, and their unrestricted use is probably detrimental in many places. In the tropics, as in the northern regions of the temperate zone, as for instance in the northwestern Canadian provinces, their use is justified in many places. Tropical plants are often materially affected by high winds, especially at a low temperature which might be 65° F. The same result is always secured from a high wind and low temperature. Heat or cold may destroy but either with wind quickly cause death. Wind breaks running at right angles to the prevailing wind, at intervals of 100 to 200 yards, will materially modify the force of the wind. Some plants grown in the lee of the windbreak will be double the size of those on the exposed side. Orange trees in South Africa when grown in an exposed position produce few roots on the windward side, hence this side of the tree fails to develop. The movement of the tree under stress of wind probably breaks them off so frequently that they cannot establish themselves.

Plants used for windbreaks. On the seashore in Southern California, the Majagua or haw (*Hibiscus tiliaceus*) is an excellent shrub for a windbreak. It will grow with its roots in the salt water and the foliage will recover from the burning of the salt-water spray. The Australian Pine (*Casuarina equisetifolia*) does well in most locations. It will thrive by the sea, where there is a heavy rainfall and is also drought-resistant. The *Eucalyptus robusta* is useful where there is an adequate rainfall. The tree may attain a height of 15 to 20 feet in two years.

Shade trees. There is marked diversity of opinion in regard to the value of shade trees. In Florida, on the Hammock land, some growers claim that a certain amount of shade is beneficial to the orange trees. No uniform practice is established as yet.

Single or multiple fruit culture. Under tropical conditions, perhaps from necessity and to avert the trouble attendant to concentration, multiple fruit culture seems to be the rule. In America, under commercial conditions, but one kind of fruit is grown in an orchard or patch, except as a temporary measure. Under California conditions, Webber suggests that multiple culture be considered and that fruits which are congenial to each other be planted together, for instance citrus and walnuts, citrus with prunes, or pears, or avocados, dates and citrus, apricots, and grapes, etc. In the Imperial and Coachella valleys, dates and grapefruit seem to thrive together, the grapefruit benefitting from the shade and wind protection. A row of orange trees grown next to but not too close to a row of walnuts may be larger than a row further away.

Weed control. Since it is impossible to cultivate some of the heavy soils of the tropics while they are wet and since the weeds must be kept under control, some other means than intertillage had to be devised. In the north, copper sulphate and iron sulphate have been used for the destruction of certain weeds, as mustard among our farm crops; in the tropics arsenite of soda has found favor as a weed destroyer.

Two pounds of salsoda or 7 ounces of caustic soda and 1 pound of arsenic are boiled together in a gallon of water until the liquid is clear. This makes 20 to 24 gallons of spraying material. It is used successfully on pineapples. The pre-war cost was about $1.25 an acre. The spraying machinery is so arranged that the plants which are under cultivation are protected from the spray, its action being confined to the area between the rows. Given a few hours of sunshine almost all plants which receive the spray will die.

The commercial situation. Very few tropical fruits are seen on our markets for the reason that there are no commercial orchards for their production. Except for a relatively few plantations tropical fruits are grown in mixed plantings of small acreage, and of little commercial importance. We have seen the recent developments of the citrus fruit industry, the rise of the banana and pineapple, and we have received the more or less uncertain supply of dates, but of the large number of desirable tropical fruits we are relatively uninformed. The public does not even know their names. The largest avocado orchards in the world are in Florida, although Florida has but recently embarked in the enterprise. Improved transportation will favor the development of tropical fruit production. Whether production of these fruits will be developed in the United States or not depends to some extent upon our future policy as a nation. There is considerable low-priced labor in the tropics and with capital these people may be put to work on the same basis as was done in the past. Large corporations may employ many hands at a low scale of wages, the laborer being almost on the same basis as the mule, working for his board. In this country higher wages must be paid.

California and Florida conditions. Since these states are the ones primarily interested in sub-tropical and tropical fruits some facts regarding these areas may be of interest. California is a land of mountains and valleys, while Florida is relatively flat, no elevation above 150 feet. California has extremely variable climate, one farm differs from its neighbor due to location, air currents and other factors, while Florida climate is relatively uniform throughout a large area. California has conditions suitable for producing almost all the temperate and sub-tropical fruits and a few tropical ones. Florida has not the same range of climate, but on account of its greater humidity and more favorable climate in southern Florida certain tropical fruits may be grown which cannot be produced in California. California has a greater variation betwen the daily and nocturnal temperatures than Florida and in addition winds which are not favorable to tropical fruits are more frequent. Florida has a relatively heavy rainfall while parts of California are arid and irrigation is necessary over considerable areas now devoted to fruit-growing. In Florida citrus and other sub-tropical fruits may be injured by temperatures they would endure under California conditions, the tendency in Florida is for vegetation to be in an active or semi-active condition all of the time, and in this condition it is more easily injured by sudden falls in temperature than are plants which are more dormant.

The soils of Florida are mainly sands in need of fertilizers and organic matter in order to grow successful crops, while California has a great variety of soils, some rich in fertility.

Propagation of fruits in the tropics. None of the tropical fruits have been given the consideration which has been accorded to fruits of the temperate zone. With Caucasian settlers in the tropics and the introduction of the methods which have been used in the temperate zones for the propagation of desirable varieties, a rapid increase in the attention given to these fruits may be looked for. It was felt to be best to develop a means of shield budding as the simplest method of propagating these plants since few fruits, relatively speaking, are successfully propagated from cuttings. Generally speaking, many of these fruits are reproduced by in-arching, but this is a makeshift and must be regarded as undesirable unless no better means is found. If one species in a genus can be budded, others can be. More species can be grafted if the right conditions are obtained and if the scions are taken in the right condition.

Budding. In shield budding some of the essential points which must be observed are:

1. The stocks must be in such a condition that the bark separates readily so that the bud can be easily introduced.

2. The budding knife should be adapted to the purpose, be sharp and be kept clean.

3. The budwood should be in the proper condition. Generally speaking, the buds on immature wood are not good. Those from the ends of the twig are usually discarded. Perhaps those of the middle growth, where the buds are well developed, are best, not taking the first growth made nor yet the last. In the Annonas, wood of the last season's growth from which the leaves have dropped naturally is used. Sometimes the falling of the leaves may be encouraged by cutting them off and leaving the wood to mature somewhat, but in other cases this may develop weak buds. Where there are round and angular twigs on the same plant, as among citrus fruits, budwood from the round growth is preferred. Where the species is thorny, budwood with small weak spines should be selected. In all cases we have exceptions: For instance, the avocado is one in which rather tender or partly mature wood, with well developed buds, is preferable to older because in the latter the buds are apt to drop off and become "blind."

4. Bud sticks should not be allowed to dry out. They should be kept from exposure to air and sun. This is usually done by wrapping in a damp cloth, or packing in wet sphagnum moss.

5. The location of the bud on the stock is sometimes quite important. In some cases the age of the stock must be the same as the age of the scion in order to secure a union. In others this is not of importance.

6. The bud should be cut clean, not torn or broken.

7. The bud should be inserted at once as soon as cut, and tied in place with waxed tape.

8. No water or impurities must be permitted to enter the bud incision.

BRIEF DIRECTIONS FOR THE VEGETATIVE PROPAGATION OF TROPICAL AND SEMI-TROPICAL FRUITS

(After P. J. Wester)

Akee (*Blighia sapida*). Use non-petioled, metallic blue-gray, mature budwood; cut the bud 4.5 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

Alacao (*Palaquium philippense*). Use non-petioled, metallic-blue, mature budwood; cut the bud 4.5 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

Alpay (*Euphoria cinerea*). Use non-petioled, light brown to greenish becoming rough, mature budwood; cut the bud 4 centimeters long; age of stock at point of insertion of bud unimportant. Congenial stock: Longan.

Anigli (*Annona senegalensis*). Use non-petioled, well-matured budwood from which the green color has disappeared; cut the buds 4 to 5 centimeters long; age of stock at point of insertion of bud unimportant. Congenial stocks are custard-apple, soursop, sugar-apple and mamon.

Annatto (*Bixa orellana*). Use well-matured, greenish-brown, petioled budwood; cut the bud 4 to 4.5 centimeters long; age of stock at the point of insertion unimportant.

Atemoya (*Hybrid cherimoya X sugar-apple*). See Cherimoya. Congenial stocks are sugar-apple, cherimoya, custard-apple and some forms of the mamon.

Atibu (*Rubus pectinellus*). Propagated by plantlets forming and rooting on the trailing plants.

Avocado (*Persea americana*). Use tender to mature, but green, smooth, petioled budwood; cut the buds 3.5 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Bael (*Aegle marmelos*). Use petioled, green or purplish, fairly mature, not old and hard, thornless budwood; cut the buds 3.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Banana (*Musa sapientum, etc.*). Readily propagated from the "suckers" that spring up from the root stock of the old plants.

Banauac (*Uvaria rufa*). Use well-matured, dark-brown, non-petioled budwood from which the tomentum has disappeared; cut the bud 3.5 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Barobo (*Diplodiscus paniculatus*). Use petioled, mature, brownish to grayish budwood; cut the buds 3 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Bignay (*Antidesma bunius*). Use petioled, green, smooth, but fairly well matured budwood with brown-colored lenticels; cut the buds 3.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Bilimbi (*Averrhoa bilimbi*). Use non-petioled, matured, brownish or grayish, still downy budwood; cut the buds 3.4 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Biriba (*Rollinia orthopetala*). See Cherimoya. Congenial stocks are mamon, custard-apple and soursop.

Breadfruit, seedless (*Artocarpus communis*). Propagated by root cuttings 25 centimeters long, 1 to 6 centimeters in diameter, inserted in sand or sandy soil during the rainy season.

Cabuyao (*Citrus histrix*). See Orange. Congenial stocks are orange and pomelo, and probably other related species.

Cacao (*Theobroma cacao*). Use non-petioled, matured, brownish or grayish budwood that has been of slow formation, of current or last year's growth; cut the buds 4 to 5 centimeters long; insert in stock at a point of approximately the same age and appearance as the scion.

Caimito—Likewise known as Star-apple. (*Chrysophyllum cainito*). Use well-matured, non-petioled budwood; cut the buds 3.5 to 4 centimeters long; insert the buds in stock of approximately the same appearance as the scion.

Calamondin (*Citrus mitis*) See Orange. Congenial stocks are orange, pomelo and probably other standard citrus stocks.

Calpi (*Citrus webberii*). See Orange. Congenial stocks are orange, pomelo and calamondin.

Canci (*Citrus histrix var; boholensis*). See Orange. Congenial stocks are orange, pomelo and probably other related species.

Carambola (*Averrhoa carambola*). Use petioled, fairly mature, smooth, purplish but not old and hard budwood; cut the buds 2.5 to 3 centimeters long; age of stock at point of insertion of the bud unimportant.

Carissa (*Carissa arduina*). Readily propagated by layering, by merely covering branches with soil and keeping moist.

Carob (*Ceratonia siliqua*). Grafting said to be in common use in Spain and Italy. Can probably be readily shield budded; fairly mature petioled budwood is suggested as suitable.

Cashew (*Anacardium occidentale*). Use non-petioled, mature budwood which is turning grayish; cut the bud 4 to 4.5 centimeters long; insert the bud in stock at a point of approximately the same age and appearance as the scion.

Catmon (*Dillenia philippinensis*). Use fairly mature, dark green or purplish, smooth, petioled budwood; cut the buds 3 centimeters long; age of stock at point of insertion of bud unimportant.

Cefalus (*Sarcocephalus esculentus*). Make hardwood cuttings of well-matured growths 25 to 30 centimeters long and insert from two-thirds to three-fourths their length in sandy soil during the dry season.

Ceriman (*Monstera deliciosa*). Propagated by the division of the stems; each part should have not less than three "eyes," or buds.

Cherimoya (*Annona cherimola*). Use well-matured, non-petioled budwood of the last season's growth from which the green color has disappeared; cut the buds 4 to 5 centimeters long; age of stock at point of insertion of bud unimportant. Congenial stocks are custard-apple, mamon, sugar-apple.

Cinnamon (*Cinnamonum zeylanicum*). Use well-matured but smooth and green petioled budwood; cut the buds 3.5 to 4 centimeters long; age of stock at the point of insertion of bud unimportant.

Citron (*Citrus medica*). See Orange. Congenial stocks are orange, sour orange, pomelo, lime, rough lemon.

Coffee, Arabian, Robusta, Quillou, Congo, Liberian, Excelsa, etc., (*Coffea arabica, C. robusta, C. quillou, C. congensis, C. liberica, C. excelsa, etc.*) Use well-matured, green to brownish or blackish, non-petioled scions; cut the buds 3.5 to 4 centimeters long; age and appearance of stock at the point of insertion unimportant. Readily cleft-grafted. Then, cut scions 5 to 7.5 centimeters long, and insert in stock preferably not more than 2 centimeters in diameter, 10 centimeters above the ground. Seal all wounds with grafting wax. In order to produce normal trees the scions should be made from vertical growths. Liberian, Excelsa and related species are considered the best stock.

Cubili (*Cubilia blancoi*). Use non-petioled, green and smooth to turning brown and rough, slender, fairly mature budwood; cut the buds 4 to 5.5 centimeters long; age of stock at point of insertion of bud unimportant.

Custard-apple (*Annona reticulata*). See Cherimoya. Congenial stocks are soursop, mamon, sugar-apple.

Dalinsi (*Terminalia edulis*). Use petioled, with tomentum disappearing to smooth, fairly mature, brownish or grayish-green budwood; cut the buds 3.5 to 4 centimeters long; age of stock at point of insertion unimportant.

Date (*Phoenix dactylifera*). Propagated from the suckers growing at the base of the palm.

Duhat (*Eugenia jambolana*). Use barely mature, green or reddish, smooth, petioled budwood; cut the buds 4 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Durian (*Durio zibethinus*). Use non-petioled, fairly mature, but not old and hard budwood; cut the bud 2.5 to 3.5 centimeters long; age of stock at point of insertion of bud unimportant.

Feijoa (*Feijoa sellowiana*). Said to be propagated by layering in California and France. Has been shield budded at Lamao Experiment Station.

Fig. (*Ficus carica.*) Readily propagated by cuttings, 25 to 30 centimeters long, from well-ripened wood of last years growth or older.

Genipa (*Genipa americana*). Use mature, bluish-green, smooth, non-petioled budwood; cut the buds 4 to 4.5 centimeters long, age of stock at point of insertion of the bud unimportant.

Granadilla (*Passiflora quadrangularis*). Propagated by cuttings, 25 to 30 centimeters long, from well-matured vines, inserted in sand or sandy soil.

Grape, Labrusca, Vinifera and hybrids (*Vitis labrusca, V. vinifera*). Propagated by cuttings from well-ripened vines, 25 to 30 centimeters long, or by grafting.

Grape, Muscadine (*Vitis rotundifolia*). Propagated by layering during the growing season, and by cuttings of well-ripened vines, 25 to 30 centimeters long, inserted in sandy soil during the dormant season, or by grafting.

Grapefruit. See Pomelo.

Guava (*Psidium guajava*). Use mature, barely brown-colored, petioled budwood; cut the buds 2.5 to 3 centimeters long; age of stock at point of insertion of the bud unimportant. Perform work from November to May.

Guisaro (*Psidium molle*). Use non-petioled, mature, gray to brownish budwood; cut the bud 3 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Hevi (*Spondias cytherea*). Use non-petioled, slender, mature, but green and smooth budwood; cut large buds with ample woodshield, 4 to 4.5 centimeters long; insert the buds in the stock at a point approximately of the same age and appearance as the scion. Stout cuttings may be rooted.

Hondapara (*Dillenia indica*). Use non-petioled, slender, fairly mature, green to brown, hairy budwood; cut the buds 3.5 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Iba (*Cicca disticha*). Use non-petioled, fairly mature, green to turning brown, smooth, slender budwood; cut large buds with ample woodshield, 4 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Icaco (*Chrysobalanus icaco*). Use petioled, fairly mature, greenish-brown budwood with lenticels well developed; cut the bud 3 to 3.5 centimeters long; age of stock at point of insertion of bud unimportant.

Juani (*Mangifera odorata*). See Mango. Congenial stock: mango.

Jujube (*Zizyphus jujuba*). Use mature, grayish, tomentose, petioled budwood; cut the buds 3.5 to 4 centimeters long; age of stock at point of insertion not important.

Katuri (*Garcinia venulosa*). Use mature, smooth, green, non-petioled budwood; cut the buds 3.5 to 4 centimeters long; insert the buds in the stock at a point approximately the same appearance as the scion or at the most where streaked with gray.

Ketembilla (*Aberia gardnerii*). Use petioled, perferably spineless, not too old budwood with tomentum still present; cut buds 3 to 3.5 centimeters long; age of stock at point of insertion of buds unimportant.

Kumquat (*Citrus japonica*). See Orange. Congenial stocks are sour orange, orange, and probably several other related species.

Lanzon (*Lansium domesticum*). Propagated by cleft or side grafting. The scion should be well matured but not of old growth, 6 to 8 centimeters long, 7 to 10 millimeters in diameter and inserted in the stock 6 to 10 centimeters above ground when at that height it is 7 to 15 millimeters in diameter; cover all wounds with grafting wax. Shield budding has been done, but the percentage of successful buds has been small.

Lemon (*Citrus limonia*). See Orange. Congenial stocks are sour orange, orange, rough lemon, pomelo, calamondin.

Lime (*Citrus aurantifolia*). See Orange. Congenial stocks are sour orange, orange, pomelo, calamondin and rough lemon.

Lipote (*Eugenia curranii*). Use non-petioled, turning brown and rough, mature budwood; cut the bud 4 centimeters long; age of stock at point of insertion of bud unimportant.

Litchi (*Litchi chinensis*). Use non-petioled, brown-gray, mature budwood, cut the bud 3.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant.

Longan (*Euphoria longana*). Use non-petioled, bluish-green to turning brown, mature budwood; cut the bud 4 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant. Congenial stock: Alpay.

Loquat (*Eriobotrya japonica*). Use mature, greenish to brownish, slender petioled budwood; cut the buds 4.5 centimeters long; age of stock at the point of insertion of bud unimportant.

Mabolo (*Diospyros discolor*). Use petioled, fairly mature budwood with pubescence still adhering; cut the buds 4 centimeters long; insert buds in the stock at a point where it is green or becoming gray.

Malpi (*Malpighia glabra*). Use petioled, light-gray to greenish, mature budwood ; cut the buds 3.5 centimeters long; age of stock at point of insertion of bud unimportant.

Mandarin (*Citrus nobilis deliciosa*). See Orange. Congenial stocks are sour orange, orange, pomelo, rough lemon, lime, calamondin.

Mango (*Mangifera indica*). Use non-petioled, mature, smooth, green budwood from the first, second or third flush; cut the buds 4 to 4.5 centimeters long with ample woodshield; insert the buds in stock at a point approximately of the same age and appearance as the scion.

Mangosteen (*Garcinia mangostana*). Use mature, green and smooth, non-petioled budwood; cut the buds 3.5 centimeters long; insert the buds in the stock at a point of the same appearance as the scion or at most where it is streaked with gray.

Matasano (*Casimiroa edulis*). Use petioled, fairly mature, greenish budwood; cut the buds 3.5 centimeters long; age of stock at point of insertion of bud unimportant

Mombin (*Spondias purpurea*). Readily propagated by cuttings, 50 to 75 centimeters long, from last year's growth or older, inserted into the ground about 30 centimeters in permanent position during the rainy season.

Mulberry (*Morus nigra*). Propagated by cuttings from well-matured growths 25 to 30 centimeters long, inserted in the soil. Readily shield budded; use well-ripened, petioled budwood; cut the buds 3 to 4 centimeters long; age of stock at point of insertion of the bud unimportant.

Nelli (*Phyllanthus emblica*). Use mature, greenish-brown, petioled budwood; cut the buds 3.5 centimeters long; age of stock at point of insertion of the bud unimportant.

Orange (*Citrus sinensis*). Use fairly to well-matured, petioled, green and smooth, preferably spineless and round budwood; cut the buds 2.5 to 4 centimeters long; age of stock at point of insertion of bud unimportant. Congenial stocks are sour orange, rough lemon, pomelo, lime, calamondin.

Palanau (*Rubus fraxinifolius*). See pilay.

Pangi (*Pangium edule*). Use slender, fairly mature, turning from bright green to bronze-green, non-petioled budwood; cut the buds 4.5 to 5.5 centimeters long; age of stock at point of insertion of bud unimportant.

Paniala (*Flacourtia cataphracta*). Use petioled, matured, greenish-gray to brown budwood; cut the buds 3.5 centimeters long; age of stock at point of insertion of bud unimportant.

Papaya (*Carica papaya*). Propagated by cleft grafting and side grafting. Make grafts preferably not more than 10 centimeters above ground, in stocks preferably 20 to 30, not more than 50 centimeters high, or more than 2.5 centimeters in diameter at point of union; in the cleft graft, if there is any considerable hollow in the stock, make the cleft to one side of it; in the side graft make the incision entirely outside of the hollow; make scions from sprouts about 7 centimeters long of old papayas; trim off nearly all leaf blades, leaving the petioles. Perform work late in afternoon and keep plants shaded.

Pereskia (*Pereskia aculeata*). Propagated by cuttings inserted preferably in sand or sandy soil during the dry season.

Phalsa (*Grewia asiatica*). Use mature, brownish, petioled, tomentose budwood; cut the buds 3.5 centimeters long; age of stock at point of insertion unimportant.

Pilay (*Rubus niveus*). Propagated by division of the old plant and by hardwood cuttings of well-matured canes.

Pili (*Canarium ovatum*). Use slender, mature, greenish-brown, fairly smooth budwood; cut the buds 4 to 5.5 centimeters long; insert the buds in the stock at a point of approximately the same age and appearance as the scion.

Pineapple (*Ananas sativus*). Propagated by slips, suckers, ratoons and crowns.

Pitanga (*Eugenia uniflora*). Reported to be whip-grafted in south Florida; under these circumstances it can probably be cleft- or side-grafted also.

Pomegranate (*Punica granatum*). Readily propagated by cuttings made from well-ripened growths, 30 centimeters long, inserted in sandy soil.

Pomelo (*Citrus grandis*). See Orange. Congenial stocks are sour orange, orange, rough lemon, lime, calamondin.

Pulasan (*Nephelium mutabile*). Use non-petioled russet-colored, and somewhat rough, mature scions; cut the bud 4 to 5.5 centimeters long; age of stock at the point of insertion of the bud unimportant.

Ragini (*Rubus rosaefolius*). See Pilay.

Rambutan (*Nephelium lappaceum*). Use non-petioled, brown-gray mature budwood; cut the bud 4 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant.

Rolfeia (*Rubus rolfei*). Easily propagated by layering.

Santol (*Sandoricum koetjape*). Use non-petioled, fairly mature, turning brownish, grayish and rough, rather slender budwood; cut buds 3.5 to 4 centimeters long; insert buds in stock at point of same age and appearance as the scion.

Sapodilla (*Achras sapota*). Said to be budded or grafted in India and British West Indies; details of method not known.

Soncoya (*Annona purpurea*). See Cherimoya. Congenial stocks are custard-apple and soursop.

Sour Orange (*Citrus aurantium*). See Orange. Congenial stocks are orange, pomelo, rough lemon, and probably other related species.

Soursop (*Annona muricata*). See Cherimoya. Congenial stocks are mamon, custard-apple.

Strawberry (*Fragaria chiloensis.*) Propagated by division of the old plants, and by the plantlets on the runners.

Sugar-apple (*Annona squamosa*). See Cherimoya. Congenial stocks are custard-apple and soursop.

Tamisan (*Citrus longispina*). See Orange. Congenial stocks pomelo and probably other standard citrus stocks.

Tamarind (*Tamarindus indica*). Use petioled, well-matured, brownish or grayish budwood; cut the buds 3 centimeters long; age of stock at point of insertion of bud unimportant.

Tangelo (*Hybrid mandarin X pomelo*). See Orange. Congenial stocks are sour orange, orange, pomelo, rough lemon, lime.

Tea (*Camellia thea*). Side grafted in Java. Scions made from well-matured twigs.

Tibao (*Rubus elmeri*). Readily propagated by layering.

Tizon (*Citrus nobilis var. papillaris*). See Orange. Congenial stocks are orange, calamondin, and probably other standard citrus stocks.

Tuna (*Opuntia tuna*). Propagated by breaking off and planting the joints during the dry season.

Uvero (*Coccoloba uvifera*). Preferably non-petioled, mature, but green and smooth to turning grayish, slender budwood; cut buds 3.5 to 4 centimeters long; age of stock at point of insertion of buds unimportant.

Vilatti (*Feronia elephantum*). Use petioled, turning greenish or grayish, just mature, preferably spineless budwood; cut the buds 3 to 3.5 centimeters long; age of stock at point of insertion of buds unimportant.

Wampi (*Clausena lansium*). Use barely mature, petioled budwood; cut the bud 4 to 5 centimeters long; age of stock at point of insertion of bud unimportant.

Yambo (*Eugenia jambos*). Use greenish to brownish and roughish, well-matured budwood; cut the buds 3 centimeters long; age of stock at point of insertion unimportant.

Zapote (*Diospyros ebenaster*). Use mature, but green and smooth, petioled budwood; cut the buds 3.5 centimeters long; insert the bud at a point where the stock is green or brown before it becomes rough.

PART X

CITRUS FRUITS

CHAPTER L

THE ORANGE: ITS DISTRIBUTION AND PROPAGATION

Location is a most important factor in growing oranges. All citrus fruits require a large amount of water when ripening a crop, and in some cases this is a process of considerable duration. To yield best results these crops ought to be located in regions of adequate late summer rainfall, or where irrigation is possible. Hence an adequate supply of water is essential. Frost plays a part also. The less frost the better. The citrus industry was practically wiped out in Florida in 1895. Many plantings are on high-priced land so that in order to show profit during recent years the amount paid for many plantations has had to be marked off to a varying extent. The fruit also must be in close proximity to a railroad or boat landing. In other words, just the same conditions apply as to any other line of fruit growing. A man must know his requirements and select a location which is best suited to the crop. If properly located on suitable and rich soil an orange grove should bear profitable crops for fifty years, provided proper cultural conditions are maintained. In California full bearing may not be reached until thirty-five years of age, twenty-year-old trees may produce 85 per cent as much fruit as thirty-five-year-old trees and ten-year-old trees about 50 per cent.

Orange regions. There are three well-developed regions in the United States: (1) California, with parts of Texas and the Mexico-Arizona region; (2) Central and Southern Florida, and (3) the Delta region of the Mississippi, including part of Alabama.

California: In California the climate from San Diego to Mount Shasta in the north is more or less adapted to the orange, but the main commercial production is found in Southern California. The so-called "thermal belt," comprising some 1,500,000 acres, is believed to be adapted to the commercial production of this fruit. It runs from San Diego to Butte County, is nearly five hundred miles long and varies from two or three to twenty-five miles in width, and in altitude from 30 to 1,800 feet above sea level. The foothills of the Sierras, notably in

Placer County and in Kern, Tulare and Fresno counties and in the Sacramento and San Joaquin valleys, all contain areas where oranges thrive. The Washington navel orange grows to perfection in the northern part of the Sacramento Valley. The local climate is remarkably variable and it is this factor which determines the crop which can be grown. The chief citrus areas are in the valleys of the foothills, or near the coast. For home use, oranges may be planted over the major portion of the state.

Florida. In Florida, the central and southern regions have proven most dependable although further north many acres of oranges are grown. Irrigation is not the factor it is in Southern California, since the annual average rainfall is 53 inches, most of which falls in the summer months. From late March or early April to June, it is usually dry. During June, July and August the rainfall is heavy. The autumn months are usually dry and light rains fall during the winter months.

Mississippi Delta. The Delta region of the Mississippi received its severe trial in the winter of 1894-95 when the temperature fell to 15° F. in New Orleans. The hardy Japanese varieties, Satsuma, Mardarins and Tangerines, budded on Poncirus trifoliata were the only ones which survived. Nearly all groves planted there since have been on this stock, although some are on Sour Orange. In this region, owing to the heavy rainfall and rich soil, irrigation is unnecessary. Compared with California and Florida the production of this area is small.

Soil Types. In California various soil types are in use, but the best is a deep, rich, easily worked loam. This type of soil not only aids in reducing the cost of operating, but also retains the moisture. Shallow soils and those with hardpan are not desirable, although in some places the hardpan is destroyed by dynamite. Both heavy and light soils are more difficult to manage than a loam and alkali is always a serious proposition. In Florida the orange is grown on a variety of soils—"high hammock," "low hammock," "high pine" and on some of the flatwoods land. ("Hammock" is the Indian name for hardwood forest.) "High hammock" land is elevated land on which there is an abundant growth of live oaks, hickories, magnolias to distinguish it from "low hammock" which is lower lying and in greater need of drainage, where sweet gum, live oak and cabbage palmetto usually grow. "High pine" is usually rolling land on which the long leaf or yellow pine is predominant, and the higher the pines the better the land for oranges. Some of the flat-woods land grows pines well, but where the saw palmetto predominates it is usually less desirable.

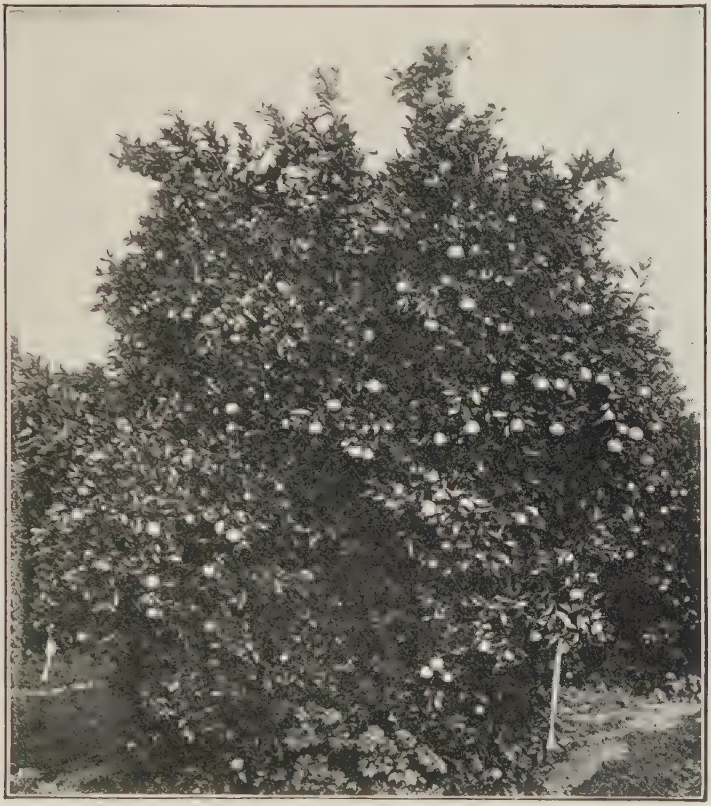

FIG. 141. A typical Washington Navel Orange tree
Professor A. D. Shamel.

Poor Soils. Land underlaid with hardpan, or which is producing low pine or black jack oaks or gall berry bushes or prairies which are apt to be flooded part of the year are worthless for oranges. Florida soil is generally light in character, and it needs plenty of humus and fertilizer. The orange tree is a gross feeder and if the material is not present in the soil it must be put there. In Florida the rainfall is heavy. Drainage is important. A water table about 3 feet below the surface is desirable.

Frost. The orange is a tropical or semi-tropical plant. When dormant it is fairly hardy, but if not entirely dormant it may be injured by temperatures which it would otherwise survive. A temperature of 24° F. frequently does considerable damage. although the Satsuma, a hardy variety, has survived a temperature of 18° F. in Southern Alabama. Frosts may not only destroy the crop, but the freezes which have occurred at uncertain intervals in Florida and Louisiana have destroyed the trees; hence the trunks are now usually given winter protection by mounding them with soil as high as possible so that even if the tops of the trees are destroyed the trunks will remain and upon them another head may be formed. Mounding, on account of the gum disease organism in the soil, is a poor practice in California. The orange groves of California and Arizona are subjected to greater winter cold than are those of Florida, yet they suffer comparatively little injury, because the cold is relatively constant and the trees remain dormant, whereas those in Florida are kept in a more or less active stage of growth by the mild winter weather, hence are much more easily injured by sudden frosts. Blizzards with their penetrating wind will sometimes defoliate the trees in Florida down to the 29th parallel. Northwest blizzards are equally destructive in Louisiana. Land which is too steep is not desirable, because it is difficult to handle and there is all degrees of opinion as to whether a northern, a southern or some other slope is best.

Winds and Heat. Regions exposed to high winds are undesirable, one common trouble being that the fruit may be damaged when blown against the branches, or it may be blown off. Intense heat is as disastrous as frost. One forceful illustration of this occurred from June 15 to 17, 1917, when a hot wave in California caused the dropping of the fruit. The navel crop was cut 75 per cent and the output of fruit was one of the smallest in recent years. Seedling trees withstood the heat better than the budded varieties.

Seedling trees. The sweet orange comes fairly true to seed. Most of the plants resulting from such seed will bear fruit which fails to meet modern commercial requirements. The standard of such trees is so much below the best that this mode of propagation is of little value. The seedling trees grow large and are then difficult to handle and harvest, hence the tendency to favor budded trees of known varieties which produce crops uniform in character and trees not so vigorous or difficult to handle.

Propagation. Varieties are usually propagated by budding desirable varieties onto either the common sweet orange of Florida, the sour orange of Florida, the pomelo or grapefruit, and "rough lemon." These are usually spoken of as sweet stock, sour stock and pomelo stock and "rough lemon." Sour stock seed is usually gathered in Florida and Cuba. A bushel contains about 30,000 seeds. If half the seeds produce plants it is a normal stand. The seed is gathered in the fall and planted immediately or it may be stored in a cool, dark cellar, or be packed with pulverized charcoal in tight containers. This is true of all citrus seeds. California usually requires 500 to 600 bushels a year. An increasing amount of the citrus fruits grown are budded on this stock. Rough lemon is handled similar to sour orange. It is sometimes used for shallow soils in Florida, and may be of value for the lemon and Washington Navel in the dry interior valleys of California. Sweet orange seed is usually gathered as needed. A bushel contains about 35,000 seeds. In the past the seedlings of the Mission Sweet have constituted the bulk of the stock used in California. Pomelo seed will stand a little drying. Pomelo seedlings make a good stock for soils which have a relatively high moisture content, but are unsuited to open porous soils. They are useful for granitic soils in California.

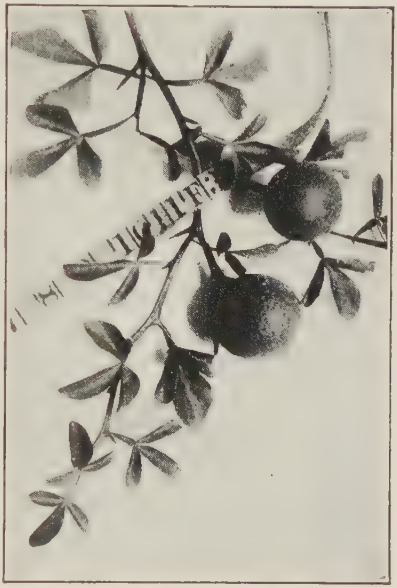

FIG. 142. Fruiting branch of Japanese or Trifoliate Orange (*Poncirus trifoliata*), used as a dwarf stock

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Trifoliate Orange. In the Gulf Coast region the Japanese orange is used. This is a very hardy thorny tree of dwarf habit and succeeds on good orange land if not too dry. Its value as a stock is its influence on the scions or buds, causing such to be more hardy and to ripen the fruit earlier, both of which are important in regions subject to late spring and early fall frosts. It is used in Northern Florida and in the Gulf Coast states for oranges, lemons, pomelo, kumquat, etc., but is not desired in regions relatively free from frost. It is not used in California to any extent. Trees grown on this stock are usually dwarfed, but there is great variation in the seedlings and in their effect upon the variety worked on them.

Seedlings. In California the seed may be planted in rows 2 feet apart, like garden beans, being lightly covered. The seedlings are raised under irrigation, often under shade. In Florida the seed is usually sown under shade, either under trees or temporary shade to save watering. When a year old and 6 inches to 15 inches tall the seedlings are transplanted to the nursery row. They may be grown a year in the seed beds before being transplanted, when they are 15 to 24 inches tall. The seed bed must be kept free from weeds and in Florida the plants need to be sprayed with bordeaux mixture, or dusted with flowers of sulphur to prevent ''damping off.'' The ''first pull'' plants are the best. The bed is gone over from time to time and the best plants are taken the first time.

Stocks for citrus. Work recently done by Webber in California indicates that there is marked variation in the seedlings which are used as stocks for citrus. This fact is recognized as quite important in regard to apples, pears, plums, etc. Webber recommends that when transplanting from the seed bed to the nursery, all small seedlings, probably 50 per cent of the total produced, should be discarded. The value of selecting the strongest seedlings has long been recognized by the nurserymen growing apples, pears, plums, cherries, etc. Webber also recommends that the larger sized trees be selected because it has been shown that in the main they retain their individuality in the orchard in the case of citrus fruits. He believes that the time is ripe for standardization of the stocks used as well as of the buds in the development of citrus fruits.

Planting in the nursery. The roots and tops are usually trimmed back before planting and the seedlings are placed in rows 4 feet wide and about 12 to 18 inches apart in the row, or about 10,000 plants to the acre. The plants are watered when set and supplied with more moisture if needed. They are given good cultivation like other nursery stock. They are budded when the bark will "slip" or open readily, either in the spring, in March or April, or in fall in September to December. The T or shield bud is used, the same as is practiced for apples. In Florida the bud is pushed upward. The tops may be removed or sometimes they are partially removed and when the bud has made 18 inches of growth the stub is also taken off. The young shoots are tied to a stake to keep them straight and when 30 to 40 inches tall are topped to 24 to 33 inches, according to the ideas prevalent in the locality, to encourage the formation of a head. They may be sold at one or two or even three years old. A No. 1 yearling will caliper one-half to five-eighths inch, sometimes seven-eighths inch. No. 2, three-eighths to one-half inch. Two-year-old buds in No. 1 will caliper three-fourths inch and up, and No. 2 five-eighths to three-fourths inch. Frequently the slower-growing tree is the more desirable, being from a tree with heavier bearing tendencies and some of the vigorous husky trees may turn out to be "hobos" and undesirable as fruit producers.

Transplanting. In California, the trees for transplanting may be taken up with or without a ball. The ball materially increases the freight, but the trees do not wilt. With the open root method usually about half of the top and all of the leaves are removed. The roots must be kept protected from the wind and sun. The open root method is used in Florida because of the character of the soil, and is advised in California because it gives greater opportunity for inspection of the root, but great care must be taken that the tree does not wilt.

Bud selection. Work done by Shamel in California shows that it is quite important that the buds be taken from superior individual trees; that there are many trees which are absolutely worthless so far as fruit bearing is concerned and that bud wood taken from such trees for propagation purposes merely reproduces worthless trees, while wood taken from profitable individuals will produce profitable trees. This is apart from the question of variety, for as with other fruits varieties must be planted which are adapted to the location. Thus the Washington Navel and the Valencia are the two best varieties for California, taking the state as a whole. Satsuma is planted where a hardy variety is required, as in Alabama.

Performance record of an orange grove. The West Highland orange grove illustrates a condition fairly typical in California. The orchard contained 1,525 trees, planted 90 to the acre and sixteen years old. The grove was considered above average in productivity. The yield per tree varied from nothing to 426 pounds of fruit. The annual expense per tree was: General care, taxes, water, pruning, fumigation, etc., $1.14 and interest on investment $1.11, a total annual expense per tree of $2.25. The fruit sold at 1½ cents a pound on the tree. Trees bearing less than 150 pounds of fruit lost money and there were 490 such, or 32 per cent of the grove. It took the profit from 646 other trees or 42 per cent more of the orchard to repay the loss incurred by keeping these 490 trees, so that 74 per cent of the grove was grown for the fun of having it. The net returns of the orchard were secured by the profit made on the remaining 389 trees or 26 per cent of the total. The remedy in this case was to top-work the 490 unprofitable trees, using for the purpose buds taken from one of the highest yielding trees, which was proven to have the inherent ability to produce heavy crops of desirable type. If the ability to produce heavy yields should be due entirely to advantageous environment, soil, etc., the tree might not be of any value as a source of bud wood, but if it had been proven by trial that it transmitted its desirable qualities then it would be of considerable value to use it as a source of bud wood. Keeping a performance record of each tree is now part of the work of running a citrus grove in the minds of many of the progressive growers.

Following the work of Professor Shamel, the California Fruit Growers' Exchange and the Nurserymen's Bud Selection Association of California are now keeping record of the performance of all kinds of fruit trees and are furnishing buds from the best trees to their members. The aim is to standardize the fruit by planting trees of known uniform desirable character and habits, and to eliminate undesirable trees.

Top-working trees. Undesirable trees are frequently top-worked. In Florida the buds may be inserted in the fall, and they lie dormant until the following spring. In California the trees are usually budded in the spring from March to June. Large limbs are sometimes removed, but part of the wood is allowed to remain to perform the function of the top. These limbs are gradually reduced as the bud acquires size.

Pollination. Some oranges and other citrus fruits require pollination in order to set fruit. Those which bear seedless fruits do not. The formation of seeds in seedless varieties is due to the influence of outside pollen. In California, most of the fruits grown commercially are seedless. Washington Navel and Valencia oranges, Eureka and Lisbon lemons, Marsh pomelo are all of this character. These varieties can be planted in solid blocks. The Washington Navel blooms contain no pollen, the Eureka lemon little.

T. Ikeda makes the following statement in regard to oranges: 1. Some varieties need a pollenizer to secure a crop. 2. Some varieties which ordinarily contain seeds, will without pollination set a small number of seedless fruits. 3. Some varieties are inter-sterile, due to uncongeniality. 4. Crossing seed-bearing and seedless varieties may produce viable seeds provided the plants used are congenial. 5. Seedless varieties do not need pollenizing in order to set and mature fruit. 6. In the Washington Navel and Satsuma varieties embryos capable of being fertilized are not usually developed, but under certain climatic conditions they occur, and it is only under the latter condition that these varieties are of use in breeding. 7. The process of pollination may be completed in from 48 to 72 hours after pollen is applied.

Orange seeds contain several embryos. An orange seed may contain several embryos. One requires fertilization in order to develop. The others are bud embryos and will reproduce the parent plant, while the fertilized embryo will not. The single seed planted may give rise to several seedlings. If it were possible to pick out those produced from the bud embryos it would be unnecessary to resort to budding to reproduce the desired plant in the case of seed-bearing varieties.

CHAPTER LI

THE ORANGE: PLANTING AND CULTIVATION

The time of planting depends upon several factors. Frequently local conditions determine. Thus in Southern California, March seems to be preferred and in the Riverside area May and June. In Arizona, April and May, although in some places March; in other words, from March to June inclusive. In Florida, the best time is during the winter months—December, January and February—although sometimes planting is delayed until the early summer, when the rains begin. Planting just before the dry time is to be avoided.

Planting distances. In California some recent plantings are 100 to 140 trees to the acre. Common distances apart are 20, 22, 24 or 25 feet each way in squares. In Florida 25 by 25 feet or 69 trees per acre is common, although some prefer up to 30 feet or 20 feet by 30, and in the case of Satsuma, 20 feet by 20 feet. On the Gulf Coast up to 40 feet apart is deemed desirable, although some groves are but 12 to 20 feet apart each way. The varieties are planted in solid blocks. In the West, usually the land must be graded for irrigation purposes before planting. A grade of 1 to 2 per cent is desirable. The land is plowed and harrowed and put into good tilth and is then ridged where the trees are to be planted. In other regions the land is put into good tilth before planting.

Planting. In planting care is taken to have the trees in good alignment. When the roots of the trees have been balled and wrapped the burlap is frequently left on the tree except the bottom; this is removed. The burlap is allowed to decay. The ball is usually pierced by a sharp stick in several places to permit the free entrance of water. The tree is planted to the same depth it stood in the nursery. An orange tree planted too deeply is injured.

Where irrigation is practiced the hole is not quite filled up to the surface and in this the water from the first irrigation collects: after this has been absorbed by the soil this basin is filled up. In Florida, land which is newly cleared is apt to be acid and some advise that the holes be dug two or three months in advance and that lime be thrown on the soil and in the hole to allow the soil to sweeten. The fertilizer is scattered on the land near to the tree site a week before planting. In California, forcing the young tree with fertilizers is questionable in the minds of several growers, but many soils are lacking in humus. The liming of the soil and the growing and plowing under of a green manure crop the previous season to increase the humus content are often advisable. Fertilizers are used on bearing trees. In Florida, after planting, a mulch of straw, leaves or trash is sometimes left around the tree to conserve moisture and add to the store of soil humus. The use of stable manure is not advised.

Management in Florida. In Florida and on the Gulf Coast soil conditions and the grower's ideas determine the procedure. On moist soils no tillage may be given, but from time to time during the summer the growth is mown. Some plow the groves in fall, turning the furrows to the trees and cultivate in spring every week or ten days during March to June or until the rainy season begins. Others cultivate in November or December to break down the weeds or cover crop instead of plowing. As soon as the rains start the cover crops are sown or the weeds are allowed to grow. Usually a legume like cowpeas, velvet bean, beggarweed or other crop valuable for the nitrogen and humus it will return to the soil, is preferred. It is generally advised to mow the cover crop if it is heavy, letting it decay on the land rather than to plow it under green.

Management in Louisiana. In Louisiana the custom is to work the land until the trees are large enough to shade the ground after which the weeds are allowed to grow and these and any brush which may start are cut. It is claimed that both late and early tillage have a tendency to induce a sappy growth which is apt to be injured by frosts. This is in a region of heavy rainfall.

Management in California. Cultivation varies somewhat with the soil. A loam 8 feet or more deep, friable and easily worked, provides plant food and water abundantly. The management of such a soil will be somewhat different than for a soil that is underlain by hardpan or by layers of open gravel. Generally speaking, the custom is to plow the orchard once a year in the spring, at which time the green manure crop is turned under. Some successful growers do not plow; they disk the cover crop into the soil. Thorough cultivation is given to a depth of 4 to 8 inches during the spring and summer. After each irrigation the dust mulch is re-established. Where a plow sole is established, due to the constant traveling of the horses on the sole of the furrow, it may need to be broken up every two or three years by means of the sub-soil plow, but care must be taken not to destroy many roots in this way. Sub-soiling is but an expedient, its effect is short lived. The breaking of a plow sole by means of roots of a cover crop is a much better policy. It is important that the humus content of the soil be maintained high. This is usually secured by the growing of cover crops for green manure, although in some cases where the trees are large, this is impossible and the growers have resorted to mulching. In some cases orchardists have used mulch entirely—applying 8 to 10 inches of straw, stable manure, hay, bean-straw—and some even suggest the use of kelp. Where cover-crops are grown, and this is the practice wherever there is an ample supply of water, it is undoubtedly one of the best ways of maintaining the humus content. With the use of cover crops and fertilizers the nitrogen content and the amount of organic matter in the soil may be greater than is found in virgin soils. When we use alfalfa or other strongly taprooted plants to penetrate the subsoil it can be said that we are using plants to subsoil and so save the use of mechanical tools.

Irrigation. In California, land is irrigated according to requirement. There are three systems: (1) The furrow, which consists of parallel furrows down which the water is allowed to wend its way. (2) The basin, where water is run from the flumes to basins which are prepared around the trees, that is, furrows are opened round the trees in such shape that the water comes in contact with the roots. (3) The pipe and stand in which the water is conveyed underground and escapes by means of standpipes. There is usually a standpipe for each tree. The overhead system is also used in small orchards. Deep furrow irrigation is the most common for oranges. It must be realized that water goes down; there is little lateral spread. The furrows must be at sufficiently frequent intervals to wet all the root-feeding area. On light soils or leachy soils 300 feet is considered plenty long enough for a furrow, 600 feet is too long. The soil at the head end will be wasting water before that at the lower end will be supplied.

Basin irrigation is used on very light porous soils and on such the aim is to run the water on rapidly in a relatively large stream. On heavier soils the aim is to run a relatively small stream for say three or four days. There are all kinds of modifications of these. The important point to consider is that the trees shall get an adequate supply of moisture and get it often enough. A soil sampler should be used and the amount of moisture in the soil determined in the surface 3 feet and to a depth of 3 to 6 feet. Often samples are taken at each 6 inches in depth, or a composite sample of from 6 inches to 3 feet below the surface. If the moisture content is too low, water is added. The leaves should not be allowed to curl on the trees for want of moisture. Usually irrigation is made every thirty days, but tests often indicate that twenty-day intervals increase the crop yield. Over-irrigation is very detrimental for many reasons—gummosis, scaly bark, malnutrition, danger from alkali, etc. It is especially so when the trees are young and growing since it tends to retain the roots near the surface, which means shallow-rooted trees. It is the shallow-rooted tree which needs heavy applications of fertilizer when it gets into bearing.

Pruning. The trees require careful training. The head should be well formed on the young trees, usually at a height of 30 to 40 inches. Four or five main branches are formed on the trunk. In many cases, after the head is formed, no cutting back of the main limbs is practiced, but branches or shoots which appear and are likely to be in the way are removed. Later on, the individual must determine the amount of pruning necessary to admit sunlight and air. The trees may be pruned to an open center system if desired, but excessive pruning is usually detrimental since it stimulates wood growth. A tree well shaped needs relatively little pruning when it comes into bearing, but a certain amount of systematic thinning will be given to remove dead wood and branches whose work is done and to renew the top from time to time. Pruning is usually done after the crop is removed, except that suckers should be removed whenever they are seen.

Shamel states that "in general the pruning in the case of good trees for the first five or six years is mainly devoted to building the permanent framework, afterward to stimulating new fruit-bearing wood in proper location. We are just starting to prune citrus. Little is known of the art. It depends upon variety, age of tree, tree condition and other factors."

It may be said that the pruning of citrus fruits varies with the variety. Thus in California some advise that the young trees of Washington Navel, which are from the best strains, be given no pruning for the first two or three years except to remove suckers and wood which will not be needed. The trees will form a good head if left to themselves. The Valencia is a more rampant grower and the limbs may need some pinching back to prevent the limbs getting too long and sprawling. The Navel is not apt to need propping when carrying its load of fruit, but the Valencia will if left to pursue its own course.

Inter-cropping. The successful production of inter-crops between oranges in the early years of the orchard, depends upon conditions such as soil, local markets, climate, water supply, etc. Vegetables are sometimes grown—tomatoes, potatoes, lima and other beans and other cultivated crops. Sometimes alfalfa is grown between the trees, the crop being mown and used to mulch the land under the trees, the area in the crop being gradually reduced so that it is eliminated at the fifth year. The growing of crops requiring the excessive use of water, as strawberries, is condemned, since it may be disastrous to the trees. On the whole there is an increasing tendency to utilize the land between the trees for other crops and to reduce the cost of bringing the orchard to bearing age, just as there is a greater appreciation of the importance of having a cover crop on the orchard some part of the season when the orchard is in bearing because of the need of maintaining the soil in good physical condition.

Cover crops. In both California and Florida the soils are usually deficient in humus. Where this condition exists, and there is a fair amount of water available, cover crops can be grown. Where there is a shortage of water, stable manure, bean straw, straw and even hay may be applied. In some parts of California, a cover crop is grown during the summer, in other sections during the winter. The crops in favor are the purple vetch, common vetch, sweet clover, cow peas, barley and vetch, Canada peas, bur clover, fenugreek and in other places cow peas and buckwheat together. In some parts of Arizona yellow sweet clover and alfalfa are used. The rate of seeding is similar to that in the East on other crops. In some sections the cover crop is sown on only half of the orchard, that is, on the portion that is not immediately under the trees. The space immediately under the trees is left vacant, but kept cultivated. Securing the right cover crop is an important factor in California and the experiments now under way at Riverside, in that state, are of marked interest.

Fertilizers. Trees usually lacking in vigor may need to be supplied with fertilizer or manure. The actual requirements must be determined by local experiment. Some California growers state that plants which are on land too rich in nitrogen make an undue amount of wood growth, the fruit is late in maturing and has thick puffy rinds, and also that plants grown on soils deficient in potash show similar skins. In some cases nitrate of soda has had beneficial effect when potash is lacking. Dried sheep manure has been used on such occasions. When manure can be secured it is frequently applied.

Fertilizer experiments in California. The Riverside station in California has been conducting fertilizer experiments which would seem to indicate that on rich California soils there is little necessity for applying fertilizer to young orange trees, but from the time they are from seven to twenty years of age an increasing amount of fertilizer may be used to advantage. Mixed fertilizers are the most commonly used, increasing the amount per tree 1 pound for each year, starting in with 4 pounds at five or six years old and furnishing 20 pounds per tree at twenty years old.

There is difference of opinion as yet as to what fertilizer should be used. The amounts applied vary from 2 to 40 pounds per tree, depending upon the conditions, size and age. Some prefer to apply all the fertilizer at one time, early in spring, while others believe it is better to make two or three applications. Some advise that in deep, rich soils in which the humus content is high an application of 10 to 15 pounds of ground phosphate rock with the cover crop is sufficient. In some cases, nitrate of soda is advisable, while in other sections its use is looked upon with question because of the fact that it is liable, on heavy soils, to form black alkali and orange trees are very susceptible to alkali. It seems to be recognized that practically all of California orchards when in full bearing need some fertilizer. Stable manure, bean straw, alfalfa hay, supplemented with sulphate of ammonia or other quickly available fertilizers, are in use. Applications of lime are sometimes profitable. Two things stand out in the fertilizer tests: (1) Nitrogenous fertilizers furnishing 250 to 300 pounds of actual nitrogen per acre, half in an organic form are usually of value; and (2) organic matter in some form is beneficial.

Fertilizers in Florida. In Florida, fertilizers may not be needed the first year or two of the orchard, if the soil is naturally rich. By the time fruiting begins, which is expected in the third year, it is essential to apply fertilizers and add increasing amounts until the tree gets into good bearing at about six years old, at which time 800 to 1,500 pounds per acre of a mixture of sulphate of potash, bone black and sulphate of ammonia is usually applied in November to February, and again in May, June or July. Sometimes a third application is given as the fruit is maturing to aid in filling it out. Usually large amounts of fertilizer can be used provided a proper balance is maintained between the ammonia and potash. On moist hammock land near the Manatee River it was considered unsafe to apply more than 10 pounds of commercial fertilizer per year to a tree, while on high pine land it was profitable to apply 80 pounds to the tree or 2 tons per acre, but a common amount is 20 to 30 pounds per tree, of the materials as above indicated.

Fertilizers in Louisiana. In Louisiana, on land naturally much richer than in Florida, it is recommended that a fertilizer carrying 50 pounds of nitrogen, 50 pounds of potash and 25 pounds of phosphoric acid per acre be applied in March or April.

Lime. In Florida, on soils deficient in lime, applications of 2 tons per acre of ground limestone may be beneficial. This is also found to be true in some groves in California. In some instances lime has had an injurious effect upon citrus fruits. The addition of limestone to some soils has caused a distinct yellowing of the foliage. This is more apt to occur on sandy soils than on loams. Two types of injury are recognized: (1) There is a lack of green color in the area between the largest veins of the leaves, and (2) there is a more or less complete yellowing or whitening of the whole of the leaf. The extent of the injury bears a ratio to the amount of lime in the soil.

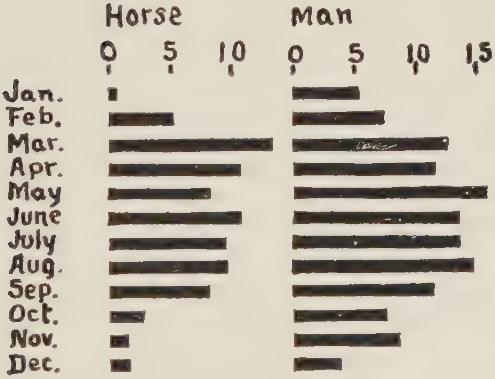
Hours of labor. Based on surveys made during 1915-17 inclusive by the California Agricultural Experiment Station, the total hours of labor per acre were 127.2 and of horse hours 82.71 which do not include the picking of the fruit.

The picking is usually handled by the association, and at that time it cost from 4 cents to 5 cents per 50-pound box in the case of oranges, and 12 to 25 cents per 50-pound box in the case of lemons.

Comparison of the distribution of the labor with that for apples will show that it is much more uniform. No farm crop in the temperate zone has so even a distribution of labor as is shown for citrus, consequently we find that there are many ranches in southern California where citrus is grown exclusively.

FIG. 143. Labor required in caring for a Citrus Grove, not including the harvesting of the fruit, in California

HOURS PER ACRE



The labor requirement is much more uniformly distributed than with most American crops

CHAPTER LII

ORANGE INSECTS, RODENTS AND DISEASES

Many of the insects and diseases which attack the orange also attack other citrus fruits. Among the principal insect pests in California are sucking insects, as the cottony cushion scale, purple, yellow, red, black, soft-brown and other scales. The citrus mealy bug, red spider, mites, thrips and others also do harm. Fortunately, not all appear at one time.

Scale insects. These are soft-bodied insects which suck their living from the trees. Some have a scale covering like San José scale. In some sections parasites aid in controlling them. The black scale (*Saissetia oleæ*) is controlled to some extent by parasites, but these do not usually hold it in absolute control. The fly aphycus is quite effective, but it in turn is subject to parasites, hence fumigation is resorted to. The red scale of California (*Chrysomphalus aurantii*) and the red scale of Florida (*Chrysomphalus aonidium*) have the same effect on the orange that the San José scale has on the apple, trees being killed in many cases in two or three years. There are several parasitic and predatory enemies which live on them, but usually fumigation is looked upon as the method of control in California and spraying in Florida. The yellow scale is somewhat similar to the red; also the purple (*Lepidosaphes beckii*). The cottony cushion scale (*Icerya purchasi*) was introduced from Australia. It attacks the trunk and branches of the tree. It is controlled by the Australian ladybird beetle and Koebele's ladybird beetle. The soft brown (*Coccus hesperidum*) and other scales are also controlled to some extent by parasites. This is also true of the mealy bugs (*Pseudococcus citri* and *bakeri*). Fumigation in California is usually practiced and consists of covering the trees with a tent and generating or liberating hydrocyanic acid gas which destroys these insects. In Florida spraying is preferred.

Foliage-chewing insects. Among insects which eat the foliage may be mentioned Fuller's rose beetle (*Aramigus fulleri*). These usually work at night. During the day time they remain near the trunk of the tree, on the underside of large branches. Since they do not fly, one way to catch them is to band the tree with a piece of cotton about 4 inches wide, or with a piece of tree tanglefoot paper over which they cannot pass. The green bug (*Diabrotica soror*) is often controlled by spraying the trees with arsenate of lead, 2 pounds to 50 gallons of water.

Thrips. The citrus (*Euthrips citri*) in California and (*Euthrips bispinosus*) in Florida, and the greenhouse thrip (*Heliothrips hamorrhoidalis*) are very small, dark-brown to almost black insects which have marked ability to jump. A generation will develop in twenty days, eight to ten generations in a year. They are controlled by spraying with nicotine to which may be added either fish-oil soap or a weak solution of lime sulphur, applied at good pressure. Aphids are controlled in the same way. The citrus white flies (*Aleyrodes citri* and *nubifera*) cause an injury somewhat like that produced by the black scale. A sooty fungus develops on the honeydew present on the foliage. This injures the appearance as well as the function of the tree. Fumigation is the method used to control in California, while in Florida some growers prefer to spray with miscible oils and fish-oil soap. As a rule one spraying in May and again in October will hold the insects in control. Certain fungi and beetles are effective in controlling these flies.

Mites. These are: The citrus red spider (*Tetranychus mytilaspidis*), six-spotted mite (*Tetranychus sexmaculatus*) and the lemon silver mite or orange rust mite (*Eriophyes oleivorus*), all live by piercing the skin of the fruit or foliage and sucking food. They may destroy the green coloring matter of the leaves and affect the vitality of the tree. The standard remedy for all mites and spiders is sulphur in some form, either dusted on dry when the temperature is 80° F. or above, or sprayed in the form of wettable sulphur or commercial lime sulphur, 1 gallon to 40 or 50 gallons of water. The mites are killed by contact so the spray must be thoroughly applied. In dusting, very finely pulverized sulphur is used, 1 part of hydrated lime is added to 4 of sulphur and thoroughly applied whenever the mites appear numerous. Since the period of incubation is five days and the sulphur will destroy the mites as they hatch, if the sulphur remains on the tree that long the mortality may be complete. If it rains, a second dusting may be necessary. A team and two men can dust 40 acres a day. The orange-dogs

(*Papilio cresphontes*) and (*P. andræmon*) are prevalent in some sections and so far the only way to combat is to pick off the larvæ and burn the affected fruit. The orange tortrix (*Tortrix citrana*) larvæ bore into the fruit usually just through the rind. The collection and destruction of the culls and the drops will usually suffice to control, but in bad infestations spraying and thoroughly coating the fruit with arsenate of lead while the larvæ are feeding is advised. A combined spray of arsenate of lead and lime sulphur may also be made.

Rodents. Various animals have to be combatted the same as with other fruits. In some sections ground squirrels injure the trees by peeling the bark near the base in seasons when there is a shortage of grass and other plants. The tree trunks may be protected by wire or other means, or the squirrels may be poisoned. This is usually best done about the last of March which is the beginning of the breeding season.

Bait for mice. The common method of poisoning mice consists of dissolving one-eighth cupful of laundry starch in three-eighths pint of boiling water and stirring well; while hot add one-quarter ounce of powdered strychnine sulphate and stir until free from lumps; then add one-quarter teaspoonful of saccharine and pour this over 5 quarts of clean barley or wheat; stir rapidly until the poison is evenly distributed over the grain; allow it to dry. This will keep indefinitely and is adequate for ten to 15 acres. Keep it from poultry and birds.

Use of carbon bisulphide. Some burrowing animals are destroyed in their burrows by means of carbon bisulphide. If the ground is very dry the fumes will not penetrate down into the bottom of the furrow. It should be used when the ground is damp. It is explosive and care must be taken to keep it from fire or lighted matches. Calcium cyanide is also used. The exhaust from the gas engine of an automobile turned down a hole has the same effect. Feed an additional amount of lubricating oil to the cylinder to make a heavy, smoky exhaust. Pocket gophers are often detrimental to orchards. They chew the bark of the roots of the trees. They are usually trapped or poisoned with a bait as described.

Fumigation is accomplished by placing a tent over the tree and generating or liberating hydrocyanic acid gas. Potassium cyanide, 98 to 99 per cent pure, is used in some cases. More often sodium cyanide is used. The grade of sodium cyanide sold as 126 to 130 per cent is the one preferred. The other ingredients used are sulphuric acid. When potassium cyanide is used the proportions are 1 of potassium cyanide, 1 sulphuric acid, and 3 of water. When sodium cyanide is used the proportion recommended is 1 of sodium cyanide, 1½ sulphuric acid and 2 of water. The amount to use will depend upon the size of the tree to be treated. The man in charge measures the tree and determines the amount. The tent is erected and put in place. The cyanide pot is put under the tent, the required amount of water being measured and placed in it. The acid is then measured and poured into the water. (Don't attempt the reverse.) The cyanide which is held in one hand is poured into the generator containing the water and the acid; the operator drops the edge of the tent so that the fumes are all detained inside. Usually three men work in a gang. The cyanide should consist of pieces of an inch to 1½ inches across. Cakes weighing about an ounce each are now on the market. The use of small pieces or powder is dangerous, both to the operator and the tree. The evolution of the gas is usually complete in five minutes. The gas can be secured all ready prepared and a measured amount liberated for each tree. The actual amount to use for the different trees can be secured from tables issued by the various experiment stations.

Time to fumigate. Fumigation is usually done at night, preferably on a still night. Usually thirty tents are in use and are moved once in every 45 to 60 minutes, the time depending somewhat on the insect under treatment. The temperature should not be above 65° F. and not below 38° F. The work should not begin before the sun disappears at night and should be over before the sun rises in the morning. In California it is usually preferred between August and January. It is not advisable to fumigate in the rain, since the tents when wet retain the gas too long and in addition are heavy to handle. The inability of the gas to escape may lead to the loss of foliage and fruit. One fumigation may be adequate for two years.

Injuries from fumigation. If not done at the right time the tree may be injured to a slight extent. The old leaves may drop but new ones will soon be formed. If the tree is not healthy there may be a heavy dropping of leaves and in some cases the fruit may be injured and drop. The fruit is most easily injured when it is one inch in diameter. The Navel and Valencia oranges are the least susceptible to injury, Mediterranean is next and St. Michaels more so. Young grapefruit are as easily injured as oranges, but young lemons are not so easily injured.

The fumigating outfit. On a large grove it pays to have one's equipment for fumigation but in many districts co-operative organizations own an outfit which does the work for the locality, more or less efficiently. When done by the community outfit some of the trees may be fumigated when it will not do the most good. The use of a fumigating machine in which the hydrocyanic acid gas is generated and from which it is passed into the tent by means of a 4-inch hose gives promise of displacing the older way of generating gas, with a great saving in risk to the operators and the tents. By this means much better control of the insects is secured on the lower branches and center of the tree which is a distinct advantage.

Diseases. Gummosis is due to many causes, fungi in some instances at least, maldigoma or foot rot (*Phytophthora terrestria*), sclerotinia gumming (*Sclerotinia libertiana*), the brown rot (*Pythiacystis citrophthora*) and the gray fungus (*Botrytis cinerea*) being recognized causes. The sour orange is resistant to the brown rot which is common in California. Lemons are most susceptible and the sweet orange is between the two. Therefore the sour orange is used for the root stock and the base of the trunk in California. The bud should be inserted so as not to come in contact with the soil at the collar, for it is at the ground level that infestation frequently takes place. Painting the affected trunk with bordeaux paste, 1 pound copper sulphate, 2 pounds unslaked lime and 6 quarts of water is advised. The soil is removed and the base of the tree is painted down to the crown roots, injured bark being first removed. Infected limbs should be pruned from the tree. Over-irrigation may cause gummosis to develop.

Root rot and toad stools are sometimes found growing on decayed roots and parts of the tree below ground and sometimes at the side of the tree. A white wood-rot soon follows and the trouble may spread from tree to tree so that the entire grove may be affected. The roots of healthy trees may pass into the infected area, thus carrying the disease. The aim should be to check and control it. When trees have to be removed others should not be planted for some time, often four or five years. Old roots of other trees should be removed for the disease may spread on them.

Maldigoma or foot rot is widely distributed. The bark decays at the surface of the ground and gum exudes just above the soil level, the wood becomes rotten and a disagreeable odor is present and the tree becomes unthrifty. The disease is generally seen on trees growing on wet and heavy land. Removal of the soil to expose and permit the removal of the injured bark and the use of bichloride of mercury 1 to 1,000 or carbolineum avenarius and then bordeaux mixture or a thick wash of air-slaked lime and sulphur on the wounds, the exposed roots and trunk; stirring of the soil and the use of the sour stock for the root are advised.

Exanthema or Florida die-back, a physiological trouble, is usually seen on trees which are on soil lacking in fertility or where the moisture content is quite variable, too wet and too dry; and on soils where the soil nitrogen is not present in the nitrate form in sufficient amounts but is present in the form of organic nitrogen and ammonium compounds which are known to cause trouble if present in large quantities. Control is to correct these conditions, stop cultivation, use fertilizers from an inorganic source only and those rich in potash.

Trunk rot is frequently seen where large limbs have been injured or removed. The wood begins to rot and toadstools grow on it and decay sets in. The remedy is to remove the rotting wood and fill the cavity with grafting wax or wound dressing.

Mottled leaf or Chlorosis is a disease causing leaves to turn mottled or yellow in Southern California. It has been held that it is the result of unfavorable conditions for growth, but the cause is obscure. It may be due to an excess of ammonia in the soil which is toxic to oranges.

Scaly Bark or Psorosis. The bark appears shaggy, gum exudes, the disease spreads, limbs die, but new wood keeps coming. The worst trees should be removed and all diseased branches removed. In late spring or summer the affected areas should be thoroughly scraped and the area round them painted with bordeaux paste. Scaly bark of Florida is not the same disease as Psorosis or scaly bark of California.

Anthracnose, Withered Tip (*Colletotrichum glœosporioides*). The tips of the trees wither. The trouble is often seen in Florida. The fruits on the diseased trees have somewhat sunken spots which are sometimes known as anthracnose spots. It also attacks the twigs and leaves and causes the young fruit to drop. Wet, cold weather aids its development. It may be prevented by pruning to maintain satisfactory growth and sprayings of bordeaux mixture, although such treatment is not always profitable.

Damping-off (*Rhizoctonia sp.*). Young seedling trees in the nursery are often affected by the damping-off fungus. The trouble begins usually just below the surface of the ground. The tissues break down and the tree falls over. The only way to prevent is to keep all the conditions for growth favorable. Spraying with bordeaux mixture may aid.

Black Pit, Citrus Blast (*Pseudomonas citriputeale*) is sometimes seen on lemons which are over-ripe. Dark brown to black depressions one-eighth to one-half inch in diameter appear on the rind, due to a bacterium obtaining entrance through some wound. Prune the trees to form a compact head to protect against wind injury.

Twig Blight, Cottony Mold or White Rot (*Sclerotinia libertiana*). The fungus causing this disease may develop in the soil during the rainy weather, also on the green manure crops, particularly vetch. The disease is most common in wet years, appearing on twigs as white mold; on the fruit it may pass from one lemon to another while they are in the wash water or if lemons are allowed to stand after harvest. The fungus develops as a white mold and appears over the surface of the lemon. If the disease is prevalent vetch should not be used as a cover crop.

Brown Rot (*Pythiacystis citrophthora*). This is more commonly seen on lemons than on oranges. It causes a brown, rather dry decay of the rind. The fungus lives in the soil and is passed from one lemon to another after harvest, or while they are being washed. The fungus lives on the bark, causing exudation of gum. Such affected areas must be thoroughly cleaned out and the wound treated with bordeaux paste. The fungus is destroyed by placing it in a copper sulphate solution of 1 to 1½ pounds to 1,000 gallons of water, accordingly the lemons are washed in this to check it. If the wash water used is alkaline it may take more. To be effective the treatment must be made within eight hours after infection. Washing the fruit or holding it in hot water at a temperature of 115 to 120° F. for two minutes is more effective. Spraying the ground under the trees and the trunk of the tree with bordeaux mixture every fall is worth while.

Blue Mold (*Penicillium italicum*) and **Green Mold** (*P. dig-*

itatum). These are the common causes of decay in citrus fruits. They usually make their entrance on the surface of the fruit where bruised or otherwise injured. Formerly much fruit was lost from these diseases but with greater care in the growing and handling of the fruit these diseases have been materially reduced.

Gray Mold (*Botrytis cinerea*). This is not serious; it usually develops on weak fruits and is seen on the rind of lemons. It may develop on fruit in cold storage when it is caused by gummosis on the tree.

Black Rot (*Alternaria citri*) occurs in wet weather and is more commonly seen on the Navel orange as a dry black rot at the navel end. Usually it is not serious. The Red Rot frequently occurs on lemons as a dry, red, sunken area. Its cause is unknown.

Puffing. In certain seasons the surface of the skins is rough and the skin itself spongy, the whole orange being soft. This is usually due to unfavorable moisture conditions.

Splitting. Oranges sometimes crack and split before becoming mature; this is more often seen in dry and hot weather and may be due to lack of proper development of the rind.

Galls. Some of the gall-like growths which occur on the branches are believed to be due to the same bacterium which causes crown gall on peach and other plants. Galls do not appear to be serious.

Citrus Canker (*Pseudomonas citri*) is one of the most serious diseases of citrus fruits and should it become generally distributed it would be a great handicap to the citrus industry. The disease is seen on the leaves, twigs and fruit of the grapefruit as small spots which finally coalesce. The area is light brown in color and is coated with dead cells. The dead area may project on the surface on both sides of the leaf. On twigs a year old the injury appears as a canker confined to the outer tissue of the bark. The organism may remain alive and virulent for twenty-six months. The infected trees should be destroyed where they stand by burning them. An oil or gasoline spray is applied to aid combustion or a torch is used. After the tree is completely destroyed, the soil where the infected tree stood is disinfected with formaldehyde and water.

Melanose (*Phomopsis citri*) is a fungus disease which attacks the fruit. It lives on the young stems of all kinds of citrus fruits in Florida. The spores are carried by birds and insects and these maintain the infestation. Removal of dead wood and spraying with bordeaux mixture 3:3:50 plus 1 per cent oil as emulsion as soon as the bloom falls is advised. If bordeaux is used alone greater care must be taken in the control of certain injurious insects for it is now known that the application of fungicides frequently prevents the spread of diseases which tend to check the growth of the insects themselves. For instance, the white fly is controlled to a great extent by a fungus which grows during the wet weather and bordeaux spraying destroys this fungus. Aphids are more troublesome on well-sprayed trees, probably due to the same reason; hence the addition of the oil to the bordeaux mixture to check these insects. Removal of the stem buttons by gassing reduces the loss from stem end rot in the fruit. The fruit is held thirty-six hours in an atmosphere charged with carbon monoxide which may be secured from the exhaust of a gasoline engine. This also colors the fruit.

Scab (*Cladosporium citri*) occurs in Florida and is especially common on grapefruit, sour oranges and lemons. Three sprayings with 3:3:50 bordeaux mixture plus 1 per cent oil emulsion just as the new growth begins, during bloom and when the fruit is set, are suggested. Some advise half the amount of oil for the second and third sprayings.

CHAPTER LIII

FROST AND ORCHARD HEATING

From time immemorial crops have been destroyed by frost. In Europe, for hundreds of years, men have tried to save their gardens and vineyards by smudging. At the close of the nineteenth century orchardists in this country began to make a careful study of orchard heating and the practice has been placed on a firm foundation in some places.

Heating important for citrus growers. It is of more importance to citrus growers than to growers of deciduous fruits because with the former the crop may be on the trees the entire year. This is especially true of the lemon. There is a critical period of four months usually from November 15 to March 15 in California. With fruits like apples or pears the danger period is short, often being only a few days in spring while the trees are in bloom or while the fruit is small.

When frosts occur. Frost usually occurs on still nights when the air is dry and the sky clear. Under such conditions the cold air settles near to the ground and it may be ten degrees colder than the air 10 to 15 feet above ground. Hence a light wind might prevent frost. A cold north wind and a dust-free atmosphere also favor frost. While there are certain so-called "frost-free" areas and some will claim that this side hill or that is free from frost, under certain conditions any and all parts of the temperate zone in North America are subject to frost. No part of the mainland of the United States has absolutely escaped freezing temperatures. The Florida Keys, however, have never had it. The only way to know what is going on is to have thermometers distributed through the orchards and to watch them so that the work of frost protection may start when it is needed.

Hardiness of trees. In some instances, there is little difference in hardiness between Washington Navel trees and Valencias when the trees are in bearing, but there is frequently a difference between the trees in the orchard. Orange trees, as a class, are hardier than lemon trees. Lemon trees might have their trunks split by frost and their leaves partially off, yet orange trees would show no damage except in the fruit. The

Lisbon lemon proved itself to be more resistant than the Eureka; Villa Franca proved somewhat hardier than Eureka, but not as hardy as Lisbon. This was true in the nursery and in the orchard. Grapefruit trees are more hardy than the lemon, but not so hardy as the orange. The fruit of the grapefruit tree withstands more frost than the orange. The tangerine and Satsuma orange trees are more hardy than the Navels and Valencias. The tangerine is regarded rightly as the most resistant to frost. Indications are that the King orange trees are more easily injured than Navels. Lime trees are more easily injured than orange; the Tahite lime being more hardy than the Mexican. The Citron is a little more easily injured than the lime.

Hardiness of fruits. A different condition obtains with fruits than with trees. The fruit of the Pomelo is the hardiest of all citrus. The injury to Navel and Valencia fruits varies with the locality. In many sections there is little difference but in others one advances ahead of the other. The fruits of the tangerine trees are not so hardy as Navel and Valencia. The fruits of the lemon trees are injured by temperatures several degrees higher than those which injured oranges, and the immature fruits are more easily injured than those which are ready to be picked. Lisbon fruits are less easily damaged than Eurekas. Tree ripes are more easily injured by frost than the green fruit.

The injuries resulting from frost may be summarized as follows:

1. The kind of tree.

2. Its condition, whether dormant or not. Trees which are dormant will withstand more frost. Trees in a ''sappy'' condition are damaged more easily than those more ''mature.'' Lemon trees, recently pruned, especially when the pruning had started a vigorous growth, were more seriously injured than those recently pruned; when the pruning had been done so recently that no new growth had been started, there was no difference in one case, although in another, with Eureka lemons, there was a marked difference, the unpruned trees coming through better than those pruned recently before the freeze. Unhealthy trees are more easily injured, and do not make as rapid recovery from frost injury as those in vigorous condition. Lemon trees topworked on orange trunks appear to be more hardy, and the converse is true. Orange trees on lemon trunks are more easily injured than adjacent orange trees on their own trunks. Orange trees on the trifoliate stock appeared to be more hardy, but the difference was slight.

3. Duration of the cold period. Lemon trees have been subjected to a

temperature of 20 to 22° F. for a very short time and were not injured, while the more hardy orange trees, subjected to the same temperature for nine or ten hours on three successive nights, lost all foliage.

4. Velocity of the wind. High drying winds, with low temperature, are apt to be more fatal.

5. Humidity of the atmosphere. Dry air is a poor conductor of heat, moist air is much better.

6. Weather succeeding the freeze. Most favorable conditions occur when the thawing period is gradual, but this is of small moment if the freeze has been sufficiently great to kill the trees.

Handling frozen trees. When the bark splits, it is usually advised to replace it quickly in position, or tie it in place with twine and cover with burlap. In some cases, the bark will be alive and will unite; in others, where it is dead, it will not. The sooner it is replaced, the better. Binding the bark in position prevents the extension of the injury, and any bark which dries and clearly shows that it is dead, can be removed later, at which time the wound may be cleaned and the area painted with bordeaux paste, and perhaps later with an asphalt paste. The tree should be whitewashed to prevent sunburn.

Pruning frost-injured trees. It is best to wait until the extent of the damage can be realized. This may involve a wait of five or six months or more, at which time the dead limbs may be removed. The experiments made with citrus trees agree with those made with peaches. There is no benefit from cutting the limbs back for the tree needs all the sound wood it has to build its new head.

Orchard heaters. Many kinds of heaters are on the market—oil, coal and coke burners. Oil heaters equipped with automatic reservoirs with a burner more or less separated therefrom, might find favor were not so high-grade oil required. The upkeep and overhead are high. In some groves, pipe line heaters, fed from a sunken pipe connected with a large tank containing the oil, have been installed, but the equipment is costly. A third type is a small lard-pail type of heater, which burns a low-grade oil from a free surface. These are cheap, usually made of sheet iron. They are easily handled and stored. They hold a gallon of oil. The later models hold 4 or 8 gallons of oil and burn eight hours. From 100 to 120 of the gallon size should be used to an acre. It is advisable to allow for a double row all around the sides of the orchard, or at least around the side from which the prevailing wind is apt to come. The heaters should be equipped with covers so that when they are placed and filled the oil may be covered to save it from evaporation and to prevent the entry of rain. The pots should not be placed under a tree. They are usually placed in the diagonals, although sometimes they are placed in line with the trees in one direction, so that the supply tank wagon can travel in the other to fill them.

Fuel oil. O'Gara states that the best oil for orchard heating is one of approximately 20° Baumé. Lighter oils may be used, but they burn more readily and reduce the time that one filling will last. The common means employed for lighting is to pour a couple of tablespoons of gasoline on the fuel oil in the pot and apply a lighted torch to it; in burning the gasoline it fires the heavy fuel oil. Another way is to set fire to a piece of oil-saturated waste and apply to one heater after another. Heaters are lighted as soon as the danger point in temperature is reached.

Thermometers. At least one thermometer is recommended to the acre. These are usually hung 4 to 5 feet from the ground. In reading at night, flashlights are best since a lantern may tend to raise the temperature in the immediate vicinity of the thermometer during reading. The frost alarm thermometer is usually arranged so that it sounds an alarm when a certain temperature is reached. This is usually one or two degrees above the danger point and it is generally located where the lowest temperatures are most apt to occur. It may be arranged so that wires are run from the thermometer to the house. When a certain degree of temperature is reached, the electric circuit is broken and this causes a bell to ring. A thermograph, which records the rate of fall, will indicate whether the fires should be lighted at once or whether the danger may be expected to pass over.

Cost of heating. The charge for interest, deterioration and maintenance without any firing varies from $11 an acre per year upward. The cost of heating an acre for one night for labor and fuel runs from $3 up. Orchard heaters cost anywhere from 6 to 50 cents each, and from 50 to 200 may be used per acre. The amount of oil needed per season will vary, but the usual estimate is 1,000 to 1,500 gallons per acre when twenty or twenty-five cold nights are expected, and it may cost all the way from 1 to 6 cents per gallon. An average estimate is that the heaters will have to be lit five times in a season, and they may be lit twenty-three times in the season. One tank wagon should be provided for each ten acres. Thermometers cost about $1 an acre. Torches and lighters will cost $1 to $2 an acre. Cost of the storage tank will not be less than $10 per acre on large tracts. The gallon lard-pail heaters which have a top diameter of about 7½ inches and a bottom diameter of 6¾ inches would show a burning surface of about 44 square inches at the top and an average of about 40 square inches. Under average field conditions, they hold about 5 quarts of oil. Experiments show that these heaters will burn about 2 pounds, that is 2 quarts of fuel oil, an hour if the oil is not too heavy nor too light. The larger size heaters now on sale burn eight hours without filling. They hold 4 gallons of oil.

The problem of heating. Experimental evidence shows that with a one- or two-mile breeze, an increase of 5 degrees in the temperature of an orchard can be secured by the use of 100 pounds, or about 12½ gallons of oil per hour, per acre, by burning about fifty standard orchard heaters. In California with larger heaters burning 100 gallons an hour per acre the temperature has been held 8 to 12 degrees higher than prevailing in unheated groves. In young orchards where the wind is blowing ten or fifteen miles an hour, at least two and perhaps three times as many heaters will be necessary to maintain an increase of 5 degrees as on a still night in a mature grove.

Causes of failure. In 1913, California had a severe freeze and many men failed to protect their orchards. At that time there were several thousand acres which were equipped with orchard heaters. Some of the men obtained results which satisfied. There were many groves where the entire crop was saved and where the trees showed no effects of the cold. Other men lost the tops of the trees and it took two years or more before the groves began to pay expenses again. Some growers who were successful, made enough from the first pick of lemons to pay the entire cost of heating, cost of heating equipment and to give a handsome profit in addition. The trees usually showed benefits from the heating, even when the crop was lost. In some cases, the returns varied all the way from $500 to $2,400 per acre; in one, the average net return was over $1,400 per acre from Lisbon lemons, and over $1,000 per acre from Eureka. The average cost of heating to accomplish this was $101.30. In addition, the trees which had been protected by heating were in satisfactory condition while those which had not been protected were injured to such an extent that their crop-producing power was impaired, even when the trees did not show sufficient injury to prevent their carrying fruit.

The principal causes of failure when orchard heating was done are stated to have been as follows:

1. The pots used were too small, burned out quickly, and were difficult to refill. It must be noted that in this particular freeze, the cold lasted three days, hence it was necessary to have an adequate number of pots, so that the maximum could be kept burning for a relatively long period of time.

2. Insufficient number of pots per acre. Some growers felt that 75 would be enough, whereas 200 were required.

3. Shortage of fuel. Some growers had made an allowance of 300 gallons of fuel per acre for the season. In some cases the requirements were up to 1,500 gallons.

4. The use of fuel which did not give off enough heat. It is now recognized that it is heat which is of vital importance. There is no attempt now to produce a smudge. It is a plain case of orchard heating.

5. Allowing the temperatures to go too low before lighting. The tendency today is to begin lighting for lemons when the thermometer reaches 31° F. and some prefer to start at 32° F. With oranges, a degree or two lower than this may be risked before beginning operations. Where a whole neighborhood is in orchards, and they are contiguous, the heating of one orchard helps the other. Heat from a 100-acre block may travel a mile and cause a rise of two or three degrees in unheated orchards; so that co-operation is frequently of decided value in this work.

6. Accumulation in the pots of a residue of asphalt which burns with difficulty.

7. Lack of care in reading the temperatures, and trusting to records in neighboring orchards rather than in one's own grove.

8. Becoming discouraged after partial failure.

9. Labor being insufficient or incapable. On this account, larger pots which do not need refilling so often and which enable two men to handle ten acres, if everything is in proper shape, have been made.

How to recognize frozen fruit. In badly frozen fruit the membranes enclosing each segment adhere and when separated small groups of white crystals are found between them. These are known as Hesperidian crystals. If badly frozen, there are so many crystals present that the segments show a snowy appearance and the crystals may also be seen in the pulp. Excessive heat is also said to cause a similar injury. The fruit parts with water in both cases and is actually dried and is so disorganized that it will not keep.

Removing frozen fruit. Fruit which is not badly injured may remain palatable and wholesome for a month, or even longer after the freeze, if properly handled. If badly frozen, the fruits will show their condition, and they may drop off. When badly frozen, the flavor becomes flat and insipid. It is not advised to ship such fruit. Freezing causes the skin to thicken, and the cells in some of the segments may split.

Separation of frozen fruit. Frozen fruit is lighter than unfrozen. This fact has been taken into consideration in the development of a separator. In this, the fruits are carried in single rows and they are dropped from a slight elevation of about 6 inches into a current of water which is moving at a regular speed. The frozen oranges are light and do not sink very far; they come to the surface quickly, being carried only a short distance before they come to the surface; while the heavy oranges sink much deeper and come to the surface more slowly, so that they are carried further by the stream of water. The placing of a screen, horizontally, at a certain depth in the water, and at a certain distance from the point at which the fruit falls in, brings the light, frozen fruit to the surface, while the heavy oranges pass beyond and enter into another receptacle. The fruit may need sizing first to ensure separation. Since there is some variation in the specific gravity of various fruits, it is necessary to adjust the screen to the variety being handled. This separation has proven to be satisfactory. Frozen fruits are sometimes used in the manufacture of by-products such as oil of orange or lemon, citric acid and citrates of various kinds, although if no by-product factory be near, the fruit may be used as manure or as feed for cattle.

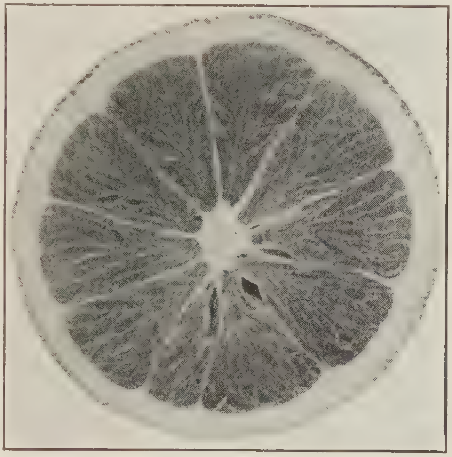


FIG. 144. What degree of freezing renders an orange unsaleable? Commissioner Hecke of California says that where ten or more per cent. is worse than that shown in the photograph, such shipment is liable to procedure under the Fresh Fruit Standardization Act. The freezing thickens the rind and causes the segments to separate

CHAPTER LIV

CITRUS FRUITS FROM ORCHARD TO MARKET

In the past oranges and lemons were injured by indifferent harvesting and packing methods which resulted in heavy loss during transit. It is now known that bruises and injuries from clippers, finger-nail scratches, injuries received during washing, from gravel or sand in the lug boxes, or from anything whatever that damages the skin, may cause loss. Hence, today all citrus growers recognize that each fruit must be handled as though it were an egg. If so handled, the grower's reputation is enhanced and his returns are increased.

Harvesting. Oranges are harvested with great care. They are clipped with button or round-pointed clippers. The least abrasion of the skin, even if caused by a finger-nail, may do damage. A little sand or dirt in a box in which oranges are hauled paves the way for the entrance of spores of decay fungi. The fruit is never pulled off because it may break the skin. In harvesting, many growers remove the lower fruit first for various reasons: One being that it is the most apt to be injured by frost; second, it is more apt to be injured by disease. Picking is usually performed by day labor. Formerly piecework was the rule, but the tremendous losses resulting from decay and careless handling brought about the change. The fruit is now put into canvas bags by the picker. These open at the bottom and are usually emptied into wooden lug-boxes. The lug-boxes are hauled to the packing-house on trucks or spring wagons, and the fruit is weighed and stored for a few days to allow the skin to lose some of its turgidity. One hundred lug-boxes will usually pack out about sixty packed boxes. Some growers harvest and market their own fruit, but in many places the fruit-growers' associations have expert pickers who harvest the fruit for the members more expeditiously and with less injury than the grower could himself.

Harvest in California. Harvesting starts when the fruit is ripe. In Central and Northern California it may begin about November, and extends two months; in Southern California with navel oranges, from January to May 1. Valencia oranges come along later in both regions, beginning in June in Central California and extending southward, ending at the Coast in November. The crop movement, therefore, extends throughout the entire year. A ripe navel will hang on the tree for two months and a Valencia for six months in first-class condition.

Harvest in Louisiana. The Louisiana crop is sent to nearby markets in the South. It usually matures about a month ahead of the Florida and several months ahead of the California crop. The varieties grown are those which mature early.

Harvest in Florida. Harvesting the early sorts in Florida starts in October, several weeks or even months ahead of the medium and late-maturing sorts, and extends to June. All varieties may be left on the trees for several weeks after ripe, without risk of deterioration, unless from frost or wind. The grapefruit harvest also occurs during the winter about the same time as oranges. Some varieties are capable of staying on the trees longer than others.

Shipping unripe oranges. Oranges have in the past been harvested green and sweated to ripen as is done for lemons. Such fruit contains an excess of acid which treatment off the tree does not change. Such fruit is deficient in sugar. The shipment of this immature fruit is disastrous to the market and is now illegal. The legal standard is that the fruit shall contain at least eight parts of soluble solids (mostly sugar) to one part of acid and be of satisfactory color.

Curing. Usually fruit is not shipped without curing. All freshly harvested citrus fruits, especially the early oranges, have rinds which are turgid with moisture and in this condition are not fit to be packed. If carefully cured, the rinds get much thinner and tougher, so that the fruit may be handled with less injury. Usually four or five days of curing is ample for oranges. Properly cured fruits may be packed so tightly that the fruits are sometimes pushed out of shape and yet the skin not be broken. The fruit is carried in good condition. Fruit may be cured in the field boxes, in a free circulation of cool, dry air.

Grading and packing. The grading, sorting and packing of oranges and other citrus fruits is commonly done in central packing-houses. These are generally equipped with machinery. Oranges will withstand considerable handling without injury when moved in padded machines. After weighing in, the fruit is allowed to cure a few days in the lug-boxes, after which it is run through the brusher to remove dust or dirt. In some cases the fruit may be sooty, soot being deposited on the fruit from the heaters or from scale insects. The fruit is often washed in water at a temperature of 110° F. in which washing powder has been dissolved, or the wash water may be a solution of one-fiftieth of 1 per cent of copper sulphate. In the washing machine the fruit travels on belts where it is assorted according to color, shape and freedom from blemishes, into three grades. The California classes are Standard, Choice and Fancy. These grades are then passed through the sizing machines which automatically deliver them into eight or ten separate and heavily padded canvas bins. From these the fruit is packed.

Packing. Packing is done largely by women. Each fruit is wrapped in a sheet of absorbent tissue paper on which there is usually some printed matter or a design. The fruit is placed in the box in a pre-arranged form, the arrangement of the layers for each different pack having been worked out in advance so that all boxes of one pack will be identical. A good packer will wrap about sixty boxes a day. Each box is packed tight so that as the fruit settles, the cover will also settle down tighter, holding it firm at all times. The number of fruits in the box ranges from 48 to 360, the common sizes running from 96 to 250. The number of fruits in the box is always stamped on the end of the box.

Grades in Florida. Before the fruit is run over the sizer for packing it may be graded. In Florida two classes are usually made—"brights" and "russets." The russet skins are those in which the skin has been injured by the rust mite and in each class are "fancy," "standard" and "culls." In some cases an "extra fancy" is put in in addition. After being cleaned, weighed and graded, the fruit passes over the sizing machine. All fruit in the same bin is of the same size. The packers work from this bin, taking up the fruit and wrapping it, placing it in the box in one of the standard packs.

The standard box. The standard Florida box contains two compartments, each 12x12x12 inches inside measurements. The standard western box is 12x12x26 inches, outside measurements. The ends usually and sometimes the sides of the box carry either a printed or lithograph label. The estimated shipping weight of a western box was 72 pounds until 1918, when it was advanced to 78 pounds. The shippers are now trying to arrange the pack to the original weight.

Half boxes. Tangerines, Satsumas and King oranges are usually packed in boxes only half as deep. They are of the standard width and length. The arrangement of the fruit is just the same, but when shipping the half-box, two boxes are fastened together by straps.

Loading the car. In loading the boxes of oranges or lemons in the car, they are placed on end with an inch or so of space between for ventilation. They are usually tiered two high, and two narrow strips of wood the width of the car are nailed to each row of boxes to hold them rigid and also to furnish ventilation. The ends of the car are filled first, the space between the doors being filled last. Great pains are taken that there may be no waste space, the boxes fitting tight. A press is sometimes used to squeeze the boxes firm in place. Motion to and fro in the car does much damage to the fruit in transit. The space between the doors may be left vacant and is then used for bracing the load.

A standard carload. A standard California car of oranges contains 384 boxes loaded two tiers on end and six rows wide, including not more than 10 per cent of sizes 96, 112 and 250 and not over 20 per cent of 126 size. The remainder of the car may be divided among the 150, 176, 200 and 216 sizes. Cars other than of standard size sell at a discount. The actual load varies with the car.

CHAPTER LV

SELLING ORANGES: COSTS BETWEEN CONSUMERS AND GROWERS

Much of the California crop is handled through associations operated in conjunction with the California Fruit Growers' Exchange. They are in fact units of the larger organization. A part of the Florida crop is sold through the Florida Citrus Exchange, although much is sold privately. The California organizations have worked out a very complete system giving them control of the fruit from the grower until sold to the jobber. The organization is the growers' representative, and it harvests, hauls, packs and sells the fruit at wholesale for its members.

Selling oranges. Data secured by the California Fruit Growers' Exchange for the years 1914 and 1915 show that California growers received an average of $1.78 per box of oranges on the cars in California in 1914 and $2.68 in 1915, or 38 per cent and 49 per cent respectively of the amounts paid by the consumers in these years. The retailer for his service received 32 per cent and 25 per cent respectively of the consumers' dollar. Retail prices rise and fall with wholesale prices. The percentage the retailer receives is usually more when the retail price is low, although the actual amount is about the same. The average retail price in 1914 was 37½ cents per dozen, of which the retailer received almost 12 cents and the grower 10.38 cents for the fruit on the tree. In 1915 the average retail price was 45½ cents a dozen of which the retailer received almost 11½ cents and the grower 18.33 cents for the fruit on the tree. In these two years, investigation showed that the average cost of doing retail food business in the United States was 17 per cent of the selling price and that the net profit was 3 per cent or a total gross of 20 per cent. During the World War period the average margin was about 16.6 per cent, of which 14.6 per cent was expense and 2 per cent profit.

The burden on perishables. In the orange business the retailer's gross margin was 32.1 per cent in 1914, and 24.9 per cent in 1915, the latter when the prices were higher. This amount was above the average of all foods because fruit is perishable and it is generally sold on inspection, also it has become a custom for grocers to handle many foods such as sugar, butter, flour, etc., at cost or even below the average cost of handling so that the profits which should have been made on the sales of such articles have to be secured by making a larger gross profit on other commodities. To illustrate, when the general overhead was 20 per cent, sugar was usually handled on a 10* per cent margin, flour on 9 per cent, butter and eggs on 7 per cent, lard 5 per cent, compound 6 per cent, and side meat 7 per cent. It may be that owing to the high value per pound of some of these commodities that the percentage margin is adequate to cover the cost of the service. About half of all the grocer sells goes over the counter without paying the average percentage overhead, and perhaps this is proper. One of the reforms attempted by the United States Food Administration and wholesale and retail grocers' associations during the war period, 1917 and 1918, was to educate the retail distributor of food so to arrange his business that all commodities he handles bear their just proportion of business charges. Fruits and vegetables are stated by some to carry four burdens—their own overhead expense, shrinkage, the unpaid balance of overhead of another commodity and the profit.† With oranges and a 16 2/3 per cent overhead in the average grocery store there would be an additional load of 3 1/3 per cent from commodities sold below cost, plus average operating cost, which would make a 20 per cent burden without any profit. Adding 5 per cent for profit would give a 25 per cent margin, in which an article bought for $1 would be sold for $1.33. The actual average margin at retail on oranges during 1921 was 27 per cent of the selling price. Giving 20 per cent of the consumer's dollar to the retailer for his services is low. Thirty-five per cent or more, as is often the case, is high, and yet in the latter case the charge may be warranted by the service rendered, in the way of special deliveries and long credits.

The advantages of co-operative wholesale distribution. The handling of fruit by the fruitgrowers as is done in the case of oranges from California is one way of insuring uniformity in packing, savings in cost of packages, supplies and cost of distribution and at the same time insuring an adequate distribution of the crop. The California Fruit Growers' Exchange found that it must use the regular channels of wholesale and retail distribution in order to secure the most economical distribution of the fruit. It is commonly accepted that an excessive price or excessive charge for the performance of a service, whether by the retailer, jobber, broker or transportation agency, reduces consumption and injures the producer.

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*Sugar may be handled for 6.5 to 7 per cent, so that a 10 per cent spread shows a 3 per cent profit.

†Unpublished records secured by the author lead him to question this contention, but the subject needs further study. Fruits and vegetables are more bulky, expensive to sell and the average sale is small. The turnover may be 50 to 100 times a year and a small margin means a handsome return on the capital invested.

The rate of turnover in oranges and lemons. In 1920, a member of Harvard Graduate School of Business Administration made a report on ninety retailers of citrus fruits in Massachusetts. This showed that one man out of ninety kept a record of his spoilage, although this man said it took but 45 minutes a week to keep a complete record of his turnover. The report shows that the lower the price, the quicker the fruit was sold; that the majority bought and sold out their oranges once a week; three stores sold out their stock once a day; two once every other day; twenty-three twice a week; six every five days; fifty-one once a week and a few stores took longer than a week. With lemons, twenty-three dealers sold out their stock once a week, some more often, but the majority took longer, and the quicker the turnover the less the spoilage.

The jobber's share in fruit. The average gross profit of wholesale grocers varies from 10 to 12 per cent. Since fruits are in the highly perishable class it would seem safe to infer that the jobber who secures 10 to 13 per cent of the wholesale selling price for handling fruit out of which he has to meet losses from decay is not receiving any larger net margin than the average food jobber. A high jobbing margin is 15 to 20 per cent of the wholesale price and 8 per cent or less is low. The fruit jobber performs a service. His work is to secure the rapid and economical distribution of his commodity and his costs vary with the locality in which he operates. In the South, West, Northwest and Canada, owing to the greater distances the jobber must travel to get in touch with his trade and the greater cost of telephone, telegraph, traveling expenses as well as wages, it costs easily 2 to 3 per cent more than it does to work in the more thickly populated areas in the Eastern states and the commodity usually passes through but one firm's hands between the Exchange and the retailer. In the case of California citrus fruits, there is a selling expense which is borne by the Exchange. They may sell carloads of fruit to the jobber; again in some markets they prefer to make sales through the auction, paying about 3 per cent commission for the service. The jobber buys the fruit at the auction and distributes it to the retailer, although if the retailer will purchase a large enough block he may buy there also.

Factors in selling fruit. To sell fruit well certain conditions are needful:

1. An adequate and relatively uniform supply of fruit of good quality. Poor quality fruit does not bring the consumer back for more. Good quality does.
2. Organization of the producers to ensure the above and to ensure standard grades and packs.
3. Organization of distributors to handle the crop.
4. A better understanding of the problems underlying the distribution of food and a more effective spirit of co-operation on the part of the producers and consumers in order to solve the problems which are of prime importance to all.

Who gets the consumer's dollar? The California Fruit Growers' Exchange has made an attempt to eliminate all unnecessary charges in the distribution of the orange crop. So far it is found that:

1. The retailer's gross margin is usually 25 to 27 per cent of the consumer's dollar;
2. The jobber's gross margin is 8 to 8½ per cent of the consumer's dollar;
3. The railroad's gross margin is 14 to 22 per cent of the consumer's dollar;
4. The non-profit, co-operative distribution from producer to jobber is 1 to 1½ per cent of the consumer's dollar; and national advertising is 0.5 per cent of the consumer's dollar.

The California fruitgrowers receive for their fruit on the tree from 30 to 43 per cent of the consumer's dollar. This system of distribution is perhaps as simple a form as is seen with any American farm crop. Under it the grower secures about a third of the consumer's dollar for his crop on the tree, if he is fortunate. It is important that the public be fully informed that the amount paid to the producer is relatively small and that the larger item of cost is for the service performed in moving the crop to the consumer. The retailer and the jobber are coworkers with the producer. Their interests are best served when all know each other and work in unison. This ensures the best service to all.

Cost of producing a box of fruit. According to G. Harold Powell, in the years immediately preceding and up to 1916 it cost the California grower an average of $1.29 to produce, harvest, pack and to place a box of oranges on board cars in California. The details of this item, together with comparative costs for California lemons, Florida oranges and Florida grapefruit are shown in the following table:

COST OF PRODUCING A BOX OF CITRUS FRUIT (1913-16*)

	California oranges	California lemons	Florida oranges	Florida grapefruit
Cost up to harvest time	$ .863	$1.00	$ .642	$ .642
Picking	.077	.253	.09	.04
Hauling	.028	.039	.075	.075
Packing	.324	.596	.50	.45
Cost packed	$1.292	$1.888	$1.307	$1.207
Freight	.828	.84	.657	.657
Refrigeration	.078	.026	(.150)	seldom used
Selling expenses	.070	.070	.160	.160
Cost laid down at market	$2.268	$2.824	$2.124	$2.024

*These dates are taken as representative of pre-war prices.

J. C. Chase and W. C. Temple in 1913 presented figures which showed that at that time a common cost of growing, packing and delivering Florida citrus to market was from $1.75 to $1.93 per box. The above figures for later years show costs of $2.02 to $2.13 per box. During the war period all costs increased materially and many have not yet returned to pre-war levels, although in some commodities, prices received have done so.

Returns and cost of producing 26,444 boxes of citrus fruits in Florida in 1911 is shown in the table below:

Boxes	Fruit	
17,988	Grapefruit returned	$2.39 per box
6,347	Oranges returned	1.23 per box
951	Tangerines returned	2.37 per box
457	King oranges returned	.64 per box
671	Lemons returned	1.63 per box
14	Kumquats returned	1.78 per box
16	Satsumas returned	.73 per box
26,444		Average $2.05 per box*

*Returns after payment of commission.

Sizes. Size is an important factor in determining returns, the sizes of the grapefruit and oranges are given. These were:

Grapefruit		Oranges	
Size	Per cent	Size	Per cent
28	3.33	64	1.5
36	7.33	80	1.4
46	17.08	96	5.91
54	36.07	126	17.1
64	20.53	150	19.3
80	9.36	176	25.
96	3.3	200	17.
126	1	216	6.16
		288	2.
not sized	2	not sized	4.63
	100.00		100.00

In this case the items of expense per box were:

	Cost per box		Per cent of the wholesale sales price	
PRODUCTION COSTS:				
Cultivation	$ .221		8.7	
Fertilizers	.163		6.4	
Teams and incidentals	.222		8.7	
Administration	.171		6.7	
Total to harvest per box	——	$ .777	—	30.5
HARVESTING COSTS:				
Labor to pick and pack	.206		8.	
Boxes, labels, paper, etc	.255		10.1	
Hauling and incidentals	.231		9.2	
Administration	.208		8.	
	—	.900	———	35.3
Total cost f. o. b. dock		$1.677		
DISTRIBUTION COSTS:				
Freight by boat		.499	10.57	19.57
Cartage			1.75	
Commission			7.25	
Gross profit per box average . . .		.373		14.63
Gross sales per box delivered average		$2.549		100.00

In the above we have a low cost for transportation, 10.57 per cent, since the fruit was moved by boat. From 1920 on, the average all-rail rate on these commodities was nearly three times as much, varying from 26 per cent to nearly 40 per cent of the wholesale selling price, all or nearly all of which is borne by the producer. Increases and decreases in transportation and other fixed charges are of material concern to the grower.

Some California data—season 1920-21. During 1920-21 season the average cost of a representative lot of California growers, not including interest on investment or depreciation of the grove for growing a box of oranges was $1.15 and for lemons $1.47 per box. The costs of picking and hauling to the packing-house averaged 20 cents per box on oranges and 49 cents for lemons. The costs of packing and loading on the cars averaged 85 cents for oranges and $1.25 for lemons, so that the total cost of a packed box on board cars in California was $2.20 for oranges and $3.21 for lemons. Transportation charges varied somewhat with the place of sale. Eighty per cent of the movement bore a charge of $1.77 per box of oranges and $1.67 per box for lemons, which included war tax. The selling charges averaged 10 cents per box. For the first three months of 1921 the average selling price was $3.71 per box of oranges and $3.16 per box of lemons delivered to the Eastern wholesaler.

Some comparisons. In other words, while the average cost delivered in 1916 was $2.27 per box for oranges, in 1920-21 it was $4.07, while in the case of lemons it was $2.82 in 1916 and $4.98 in 1920-21. In the case of Florida oranges, while a common delivered cost was $2.13 in 1916, in 1920-21 it was about $3.90. Since many of the costs such as packages, transportation, cartage, etc., are items over which the grower has no control but for which he must pay if he uses the service, it will be impossible to reduce the price unless the costs of these services are reduced. The increase in these costs, especially when the crop is large, will prevent the movement of all the lower priced grades of fruit, because the cost of handling cannot be met.

Some Florida costs 1920-21. Although 360 boxes are sometimes secured, the average yield per acre of the bearing groves was estimated as about 150 boxes. Using this factor for the state, the average cost of production up to harvest time was about $1 a box. The cost of picking, packing and loading on board cars was about $1.25 a box. Freight and refrigeration to a central point, as New York, was $1.55 a box. Selling expenses were 20 cents a box. Hence the total cost of a box delivered on the market was $3.90. The items entering into this are, per acre; 1

ton of fertilizer, $60; labor cultivating, $15; spraying three times, $30; pruning, $10 and interest on $500 investment, $40, a total of $155. The cost of harvesting and hauling 150 boxes at 30 cents a box was $45; packing and loading at 95 cents a box, $142.50; freight and refrigeration to New York at $1.39 a box, $208.50; selling expenses at 20 cents a box, $30. The 150 boxes cost delivered, $581 or $3.90 a box. Much of this fruit sold at $3.25 to $3.40 a box on the market. Low prices at destination are forcing readjustment. The less profitable groves will be abandoned, the lower grades of citrus fruits are being shipped in bulk.

Whether the producer will make a profit or not will depend upon the quality of his fruit, the yield, the cost of production, the general management of the place, and most important of all, and a thing over which he has no control, the selling price.

Yield and returns. A well-managed orange grove may be expected to produce 250 boxes per acre. The average production of 26,000 acres in California for the years 1906 to 1915 was 158 boxes per acre. In 1920, when estimating the probable amount of equipment necessary to move the California crop, G. Harold Powell took 137 boxes per acre as the five-year average yield of the bearing acreage. The average returns of any crop are low. According to data collected by Victor Newland for California conditions, the average net profit to the grower per box of oranges for the years 1908 to 1913 was 15 cents, while lemons showed a loss of 20 cents per box for the same period. Prior to the war period, and it is more forcibly emphasized today, it was recognized almost as axiomatic, that California (and the same is true of all places distant from market) needs to produce a crop or a commodity which can be sold at a price which will enable the grower to pay the charges which must be borne by it for transportation and distribution. The returns to growers are dependent entirely on a selling price which is determined daily by the operation of supply and demand, and over which the growers have little control. Advertising and creating a demand combined with the maintenance of a rigid standardization of the pack offers at the present time a means for increasing the returns.

CHAPTER LVI

THE LEMON

The lemon (*Citrus limonia*) is more easily injured by frost than most other fruits. It bears fruit and is in bloom throughout the entire season. Hence its moisture requirements are greater than any other citrus fruit. The industry is quite circumscribed, but an income can be taken from the trees every month in the year. The work is also more uniform than oranges and the crop is regarded as more desirable. On the other hand, the demand for the fruit is more erratic and the crop more speculative. An extended period of hot weather stimulates the demand for lemons.

Location. On account of the lesser ability to withstand frost the industry is centered largely in Southern California. Local conditions are very important. Generally speaking, lemons do best where the summer heat is somewhat less than is necessary to give satisfactory sweetness to the orange. This and the greater freedom from frost usually occur near the Coast or in regions subject to coast influences in Southern California. Lemon culture was assuming important proportions in Southern Florida by 1894, but the severe freeze of 1894-95 killed or caused many orchards to be abandoned. Lemon growing is now receiving attention again in Florida.

The stock. The sour orange root, used for stock, is less fastidious as to soil requirement than the lemon root and produces a tree of less vigorous growth. It is also more healthy and satisfactory. Owing to the dangers from gummosis which readily attacks the lemon, it is important that the buds be placed high on the trunk of the stock so that the lemon itself does not come in contact with the soil. Rough lemon is sometimes a useful stock for Florida. The trees are usually planted 20 to 30 feet apart in California, 20 to 25 feet is most common in Florida. The cultivation is somewhat similar to that given the orange.

Pruning and shaping the trees. The tree is naturally small with long, irregular branches. The flowers are borne solitary or in clusters in the axils of the leaves. There is a marked diversity of opinion on the question of pruning. Undoubtedly some of this is due to attempts to meet local conditions, as for instance where brown rot is quite serious. The aim in this case is to keep all fruit off the ground which results in the lower limbs being removed so that even the ground underneath the tree can be sprayed in order to prevent infestation. Other men argue in favor of the low head because the trees are more easily fumigated, sprayed, thinned and harvested. Undoubtedly there are local factors which have led to a variety of systems, but it is generally recognized that pruning should be given regularly. One of our most prominent growers holds that it is desirable to cut back leaders one-half or more and that any shoots not worthy of a place should be removed for the purpose of maintaining a symmetrical head. Young tender growth may be pinched back to make the tree more stocky, but the tree growth must not be allowed to become too dense either on the sides or

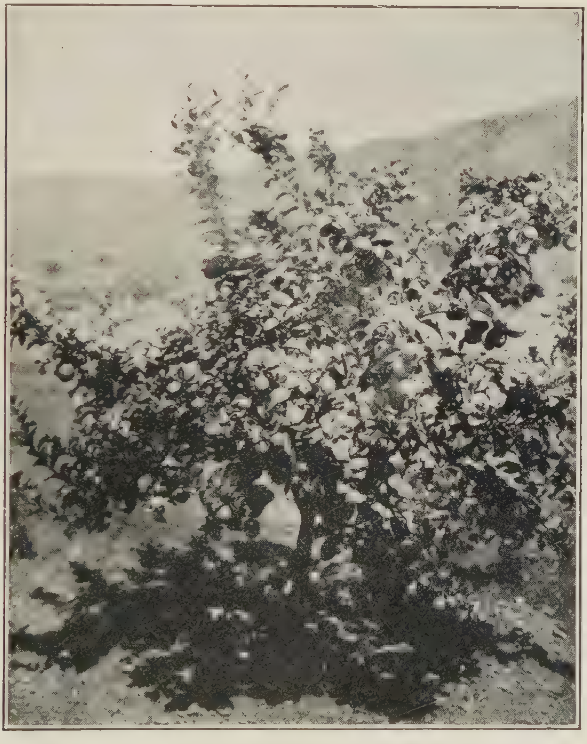

Fig. 145. Eureka Lemon Tree, 2¾ years planted and in bearing. Propagated from a selected, record-making tree
Prof. A. D. Shamel, Calif.

at the top. With an open-growing variety like Eureka there is little danger of this happening. The light should be able to shine through the foliage and strike the ground in places. A flat-top tree is not desirable. It has not sufficient bearing surface and hence is not sufficiently remunerative. Others follow the policy of giving relatively little pruning except as is necessary to secure shape. There should be a good supply of healthy fruit-bearing wood on top of the tree as well as on all sides of it.

Open center system. The open center system is somewhat like a goblet with flaring sides or like a partly closed umbrella: the limbs radiate from the trunk but have an open center, just as peach trees are grown. The upright branches in the center are removed. Fruiting wood is retained on the main branches. These main branches are trained by cutting out inner or outer limbs as the case may require; they are usually crooked and angular, but tend to produce an abundant supply of fruit buds. The aim of the system is to get much fruit-bearing wood and no useless timber. The danger line, however, is quickly reached, and with lemons as with apples or any other fruit, excessive pruning merely stimulates wood growth in the attempt to readjust the proportion of leaves to the root. Pruning may be carried so far that the tree becomes unthrifty and bears small crops owing to a failure in the growth of the root system itself.

Leader and Other Systems. The leader system consists of a central leader with the branches arranged on it. The minimum of inside fruit wood is produced on this type of tree. There are various other ideas. In some cases the trees are so shorn as to be perfectly flat, just like the peach trees in parts of Ohio. Also see Apricot. A dense growth is secured in the tops of the trees which is thinned out in both early fall and spring, at which time weak wood and decadent branches are removed. With Eureka lemons one pruner is allowed to from 25 to 40 acres of orchard and he does nothing else.

Care of the grove. The work so far as it relates to cultivation, fumigation, general orchard practice is similar to that outlined for the orange with emphasis upon the need for an adequate supply of moisture. It is not desirable that the temperature fall below 29° F. while the fruit is on the trees. Orchard heating is even more important with this crop than with the oranges. There are some groves in which it is not in use, the belief being that the climatic conditions do not warrant the expenditure.

Irrigation. In California, on most soils in the medium loam class, the custom is to arrange a grade of 1 to 2 per cent. The ditch is run on the contour if the grade is over 2½ per cent. Distribution pipe lines are arranged at from 250 to 400 feet apart. The water is run under the tree as far as possible, and also between the rows to secure the widest distribution possible. The custom is to apply 4- to 8-acre inches every five or six weeks, making the first application twenty-five to fifty days after the last soaking winter rain. A leguminous cover crop is sown in August or September and the irrigation is made at intervals of four weeks to start it. This is plowed under during the following February or March to complete the cycle. The moisture in the soil should not fall within 2 per cent or 3 per cent of the wilting point. If it does the fruits may start to drop. Each grower will have to solve his own problems in this line.

Fertilizers and tillage in Florida. In Florida, applications of from 800 to 1,500 pounds of fertilizer per acre are made usually in autumn. The fertilizer consists of sulphate of potash, sulphate of ammonia and bone black. Another application is sometimes made in early summer. Sometimes a third application is made as the bulk of the fruit is ripening. Clean tillage is given until the summer rainy season sets in when the land is seeded to a cover crop of beggar weed, cowpeas, velvet beans or other crop, part of which is sometimes removed as hay and the remaining part, or the whole of it disked into the soil in November. It has proven a better practice to get rid of the cover crop at this time rather than to leave it on the ground for the winter.

Harvesting. Lemon harvesting goes on at all seasons, the fruit being gathered once a month. In picking, lemons are usually gathered according to size. A ring is carried over the finger and this is slipped over the lemon to see whether it will pass through or not. Usual sizes are 2¼, 2½ and 2⅝ inches in diameter. The large rings are used in winter and the small ones in summer because lemons are in greater demand in summer than in winter. Hence the harvesting is done more frequently. The fruit is still dark green in color when harvested, although sometimes small lemons will become overripe and inferior before reaching a proper size. This kind is known as "tree ripes" and is second grade. The details of harvesting are similar to those of the orange. Harvesting is best performed by the association men. The fruit so gathered shows up much better at destination than that harvested by the growers. The lemon is handled somewhat differently than other fruits. The green fruit must be cured, that is, its coat must be changed from the green color to the well-known lemon-yellow color. One of the principal factors in determining the price is the color of the stock.

Lemons are cured. The fruit should have a uniformly dark green color when picked. If pale yellow, the fruit will be too deep in color when cured. Cured lemons not only are better in appearance, but have thinner skins than when ripened on the tree. They also keep better and contain more juice. In California the lemons are frequently stored for a time in a shed. This consists merely of a roof and floor divided into rooms with canvas sides and top, with spaces around each room. Each room usually holds a carload of fruit.

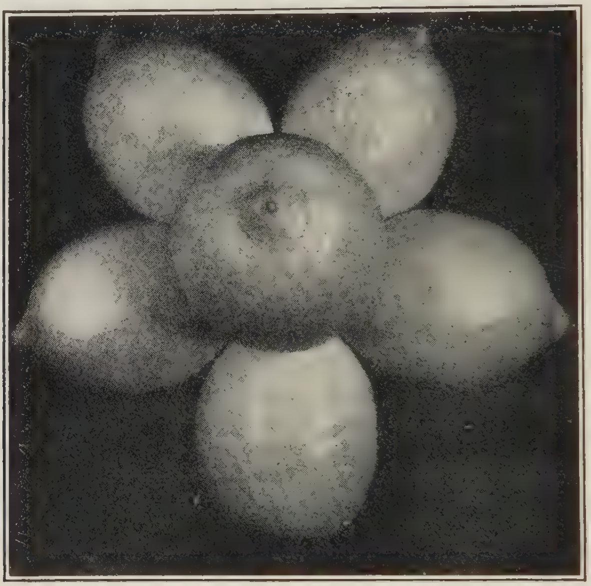

Fig. 146. Desirable Lisbon Lemons from performance record trees. Selections made for yield and uniform excellence of fruit by Prof. A. D. Shamel

Curing process. After the fruit is washed in a solution of one-fiftieth of 1 per cent of copper sulphate or in hot water it is placed in shallow trays and stacked in these rooms. The trays on the outside and on top of the pile are lined with paper. The trays are so piled that the air may circulate to remove the exhalations from the fruits. The fruit loses about one-eighth-inch in diameter during curing. Light green lemons may be cured in thirty days; other kinds of fruit may take sixty days. The aim is to give the greatest possible degree of uniformity and humidity throughout the curing period.

Sweating. Curing may be hastened by sweating the lemons and they may be prepared for market in from three to fourteen days. Thus when there is a great demand for lemons in the summer it is necessary that the curing be expedited. The fruit is subjected to a temperature of about 90° F. and a high degree of humidity, usually in closely confined rooms known as sweat rooms. Sometimes the ordinary canvas room is used, stoves furnishing the heat. This method does not give as uniform curing as is desired; the idea is to keep the air saturated with water. By means of forced curing the packer can control the movement to market to a considerable extent. If the fruit is needed the work can be rushed. On the other hand, in winter, the work may be allowed to proceed slowly and if need be the fruit can then be held pending the arrival of warm weather and a greater demand. From the curing-room the fruit passes to the packers where it is graded by hand. The packer also does a certain amount of sizing as he packs.

Standard box. The standard lemon box is 10½x12x27 inches outside measurement, divided into two compartments. The fruit is wrapped in tissue paper the same as with the orange. Lithographic labels denoting the brand and type of fruit are usually pasted on the ends of the box.

Yield of lemons. During its first nine years the Shippey Lisbon Lemon Orchard produced an average of 73 packed boxes per acre per year from fifty trees to an acre, and during the seventh to ninth year it averaged 4.53 packed boxes (90 pounds) per tree. A mature tree from which these trees were budded averaged 17 packed boxes per tree as a three-year average. Of 2,000 trees, planted 29½ feet apart each way, 300 trees or 15 per cent were lost from root rot in nine years, the stock used being sweet orange. At the end of the fifth year, the orchard paid for itself.

ANNUAL YIELD OF LEMONS FOR THE FIRST NINE YEARS

Years planted	No. trees	Total yield in packed boxes. (90 lbs.)	Average yield per tree in packed boxes (90 lbs.)
2	2,000	16	——
3	2,000	1,174	0.58
4	1,800	2,687	1.49
5	1,800	5,213	2.89
6	——	Frozen out	——
7	1,800	7,477	4.15
8	1,750	8,528	4.87
9	1,700	7,859*	4.62

*About 4,000 packed boxes lost by frost. Total average yield per tree if all had been saved was 6.97 boxes.

The yields of lemons secured on the Limoneira Company's orchard in certain blocks, as reported by C. C. Teague, were as follows:

YIELD OF LEMONS, BOXES PER ACRE, IN CALIFORNIA

Year	85 acres Eurekas frozen in 1913 at 5 years of age, packed boxes per acre	66 acres Lisbons planted 1913 packed boxes per acre	11 acres Eurekas planted 1915 packed boxes per acre
1914	3.11	——	——
1915	8.06	.05	——
1916	35.77	12.13	16.88
1917	33.13	40.05	20.62
1918	78.30	82.31	77.47
1919	85.49	124.50	116.42
1920	124.09	173.82	
1921	152.13	250.98	
Total production per acre, 8 years . .	520.08	683.84	
Total gross value per acre f.o.b. cars	$2,193.96	$2,915.17	
Less packing-house costs	$386.98	$522.34	
Net value per acre for 8 year period .	$1,806.98	$2,392.83	

The above shows the comparative yields and values of a newly planted acreage with one which had been injured nearly 50 per cent by frost.

Handling frozen trees. In spite of heaters, cold weather will sometimes cause considerable injury. C. C. Teague, President of the California Fruit Growers' Exchange, states it as his experience that fruitgrowers frequently make a great mistake in not recognizing and discounting their losses at once. As an illustration he gives the history of an 85-acre orchard of lemons which were frozen in 1913 when five years of age. It was decided to save the block. The first thing done was to go over the tract and bind up the cracks in all the trees where the wounds were not very serious, for freezing causes the bark to crack and peel off and sometimes the trees crack. All trees showing large cracks were removed. A later examination of the trees showed that the treatment was of little value, and it was decided to remove and replant the worst injured trees. Sixteen per cent of the trees were replanted the first year, the next year 10 per cent more, the third year 9 per cent more, and the fourth years 3 per cent more. Since then until 1921 8 per cent more, making a total replanting of 46 per cent in eight years. Failure to remove all of the frosted trees and to replant at once entailed a loss of $100,000 in eight years. The general advice seems to be:

1. Go through the orchard and whitewash every tree to prevent sunburn.
2. Remove all trees which do not show signs of life and leave those whose main leaders are split until June. In June, if the trunks of such trees appear strong enough to carry new laterals, the trees are left in the orchard.
3. Trees which are rotten at the heart will break down under heavy loads of fruit and are not worth keeping.
4. Trees showing crotch injury are of little or no value.
5. Delay pruning until after growth has taken place.

Diseases and insects. The common diseases which cause decline in lemon trees and other citrus are scaly bark, foot rot, brown rot, gum disease, gray mold gum disease and shell bark. The grower should familiarize himself with these, in their various stages. (See Orange.) Shell bark is more common on older trees and is an important factor in their decline. To control, scrape the outer bark from the branches to the ground between June and September and paint with bordeaux paste. Reduce the leaf surface by heavy pruning and spray the trees with whitewash to prevent sunburning. Remove the soil down to the main roots and keep it away from the bark of the trunk. Permit the free circulation of air under the trees. Internal decline shows in the center of the lemon fruit. It takes on a light pinkish-brown to rust-brown color, which does not show externally.

This must not be confused with Alternaria rot. Internal decline may be caused by an insufficient water supply. Alternaria rot is a fungus disease that enters at the stem end of the fruit, causing the internal tissues to turn brown and finally black; later the lemon goes soft and mushy.

Best selling month. The prices received by lemon growers for a period of fourteen years show that prices are usually best during the five months from June to October and that during the other seven they drop. The average prices for the best five months are about 33 per cent higher than the prices received from November to May. The fruit is on the trees ready to harvest throughout the year. The months of heaviest picking are from February to May, and the heaviest movement of lemons is usually in June.

Cost of production. H. J. Ramsey states that the data secured shows that the cost of producing, packing and shipping lemons in California increased 87.6 per cent from 1910 to 1918, that a further increase of 26 per cent took place in 1919 over 1918, and that the 1919 cost was $1.46 to produce a box of lemons, $1.10 to pick and pack, or $2.56 ready for shipment. To this must be added $1.05 freight (which was increased 25 per cent to 40 per cent, an average of 33 1/3 per cent in 1920) and 15 cents for selling costs. The box of fruit had to sell for $3.66 to cover costs. The 1920-21 costs were still higher.

Consumption. G. Harold Powell stated that the 1918-19 lemon crop of California of 9,963 cars was only 3 per cent less than the average supply of foreign and domestic lemons during the previous five years and that the production of the next decade may be expected to exceed the present combined domestic and foreign supply by at least 50 per cent, and imports may be expected to continue. With the rate of exchange favorable to the Italian lemon grower, lemons will be shipped in an increasing volume. During the last fifteen years, the annual per capita supply has remained stationary at 13½ lemons per person. The way to increase consumption is to maintain an even, moderate price to the consumer on regular merchandising rather than to market on a fluctuating speculative basis.

Selling. The lemon is sold through the same channels as the orange, but as now handled it is a speculative crop. Its principal use at present is for making drinks in summer. If its use is extended the demand will become more stable, the speculative element will be reduced and supplies will be more constant and more easily secured.

The value of cull lemons. During 1921 the Exchange Lemon Products Company at Corona, California, handled from 1,200 to 1,500 tons of lemons monthly. In the five years' period the plant had been in operation it handled approximately 40,000 tons of cull lemons. The by-products, largely citric acid and oil of lemon, were sold for $924,000, of which approximately $325,000 was paid to the shippers in cash—about $8 a ton. The average per ton for the season of 1920-21 was $7.21 net and $9.60 delivered.

Some idea of the expense involved in saving by-products can be secured from the statement of this company for the year 1920-21. The gross sales totalled $334,465.

Costs incurred were:		Per cent of total
Labor	$53,815	16.1
Supplies	35,564	10.6
Fuel, light, power, water	23,731	7.1
Interest, insurance, taxes	8,475	2.6
Experimental work	2,155	0.6
Repairs and alterations	12,084	3.6
Office and selling expense	12,573	3.8
Freight and drayage on lemons	41,511	12.4
Depreciation	20,000	6.0
Paid to shippers for lemons	124,553	37.2
		100.0

The comparative factory cost of handling a ton of lemons in 1916-17 was $13.45; 1917-19, $15.07 and 1919-20, $13.42. To save a ton of cull lemons, the average value of which was $7.21, involved the expenditure of from $13.50 to $15 additional as well as the investment in the plant. In districts where the yields are uncertain from year to year, it will be seen that it might not be financially economical to attempt to save cull fruit. Lemon growing, however, offers opportunity for steady employment to the workers and continuous use of the plant, thus reducing overhead costs to a minimum.

CHAPTER LVII

THE POMELO, LIME, CITRON, SATSUMA, TANGELO AND KUMQUAT

THE POMELO

The Pomelo or Grapefruit (*Citrus grandis*) is a native of Malaysia and Polynesia. It was introduced into Jamaica, where it became of importance commercially and is grown largely. The fruit was introduced into Florida by the Spaniards in the sixteenth century and for the past twenty-five years it has been grown extensively, some 12,000 to 18,000 cars being shipped annually. In Southern California and along the Gulf Coast are districts which are suitable for its production.

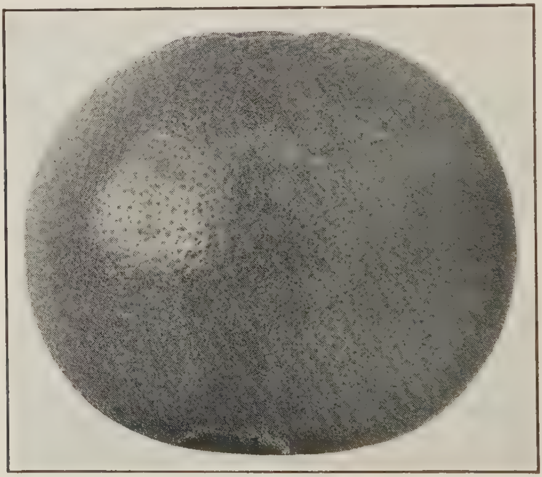

FIG. 147. Desirable type Marsh Seedless Grapefruit
Prof. A. D. Shamel

The tree is more easily injured by frost than the orange. The 1894-95 freeze in Florida killed all trees to the ground north of the central part of the state.

Selection of variety. In Florida the Marsh is now the leading variety. California is at a disadvantage in competing with Florida in the eastern markets on account of the greater expense of rail transportation and the time of year at which their crop matures. In California the grapefruit is a summer fruit, in Florida it is a winter and spring fruit. To meet this situation California is planning to raise materially the standard of its product and to supply the eastern markets during late summer and early fall when there is little Florida fruit. The Marsh seedless is the variety chosen for California. This is a flattened, thin-skinned, juicy, seedless variety which begins to ripen in May. The Florida standard of maturity is that the fruit shall contain seven parts of soluble solids, partly sugar, to one of acid.

Soil. The grapefruit prefers a well-drained, sandy loam soil, and in Florida it is generally understood that it will do better on a poor soil than will the orange. The trees need fertilization in order to produce good crops.

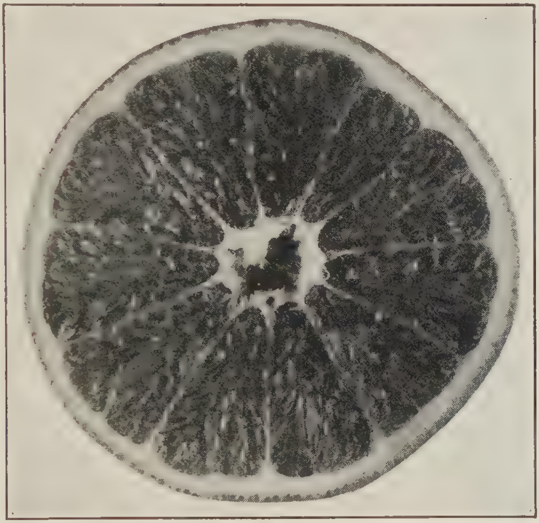

FIG. 148. Typical Marsh Grapefruit grown at Riverside, Calif. Note thin skin

Prof. A. D. Shamel

Propagation. The methods outlined for the orange are generally applicable to the grapefruit. The trees grow 25 to 30 feet high, are somewhat larger than the orange and need more room. Some growers prefer to bud the plant on its own stock, although sweet orange, sour orange and rough lemon are sometimes used. Budded trees of recognized varieties are now planted in preference to seedlings, which may or may not be of commercial value. Budded trees may begin to bear at three or four years of age and reach full bearing in about ten years. The trees are not so liable to disease and insect troubles as the orange, although they are quite subject to citrus canker.

Harvesting The pickers should harvest for size. The demand in the fall and early winter is for the larger sizes. Medium sizes are in less demand and small sizes are at a discount. Toward the latter end of the season conditions are reversed. The large sizes are at a discount, many buyers prefer medium size and small fruit. The yield and the grower's income can be increased by catering to the demand.

Storage. Grapefruit may be held in cold storage for one to three months if properly cured before storage. Curing is effected by holding the fruit in a warm room at about 70° F. for two or three weeks. The fruit may then be held at 32° F. "Pitting" or the development of sunken spots on the skin may result if the fruit is not properly cured before storing. The fruit that stores best is picked about midseason. If ripe fruit is left on the tree, the seeds are apt to sprout and the fruits lose flavor, but in storage the acid content of the fruit decreases and the bitter principle breaks down, while the sugar content appears to be unaffected, so that the flavor is improved. Fruit harvested in February or March may be held for shipment in May to July. In Florida, harvesting proceeds from November to August. Some fruit may be on the trees throughout the year.

THE LIME

Until recently the lime (*Citrus aurantifolia*) was used as the source of lime juice and for the manufacture of citric acid. The introduction of limeade into the soda water fountains has increased the demand for this fruit.

Varieties. The common kind is usually designated West Indian. The plant is a bush. The fruit is small, seedless, sour and is produced abundantly. It comes into bearing about the third year. The fruits are shipped during summer and autumn to the Atlantic Coast cities. Mexican, Tahiti (Bearss Seedless), Persian and Rangpur are grown. Thornless, a recent introduction, is on trial.

Soil and Climate. In the West Indies and Florida the low growing, much branched, thorny lime trees are found thriving on the poor, rocky soil, in closer proximity to salt water than any other member of the citrus family. The trees are more easily injured by frost than the lemon, and are little grown in California. In the colder regions there is a possibility of growing the Calamondin orange (*Citrus mitis*) which bears a fruit resembling a small tangerine and makes a good ade. It is as hardy as Satsuma and can be budded on sour orange or trifoliate orange stock.

Propagation. The best varieties are propagated by grafting or by budding on stock of sour orange or rough lemon, but at present the bulk of the trees are seedlings. It is suggested that budding the lime on *Poncirus trifoliata* would enable it to withstand more severe weather than it can when worked on more tender roots.

Planting. When planted they are usually set out 15x25 feet and given cultivation as outlined for oranges.

Harvesting and shipment. Limes are harvested throughout the year like lemons. The few limes that are shipped are packed the same as lemons, usually in a lemon case. The ordinary Mexican sour limes, the ones usually found on the East Coast, are generally shipped in boxes holding about two bushels each, without any wrapping and in a somewhat crude package. Sometimes they are picked green and shipped in barrels. They do not handle as well as cured lemons, being so thin skinned. No processing of the fruit is practiced.

Diseases. Anthracnose or wither-tip is sometimes serious. It destroys the smaller twigs and branches, and attacks the fruits of the Mexican lime, causing wart-like spots. To control, remove dead and diseased wood and spray with bordeaux mixture.

Limequat is a hybrid between the common lime and the round kumquat. It possesses the following advantages: It is more hardy than the lime; it is resistant to citrus canker, and it promises to be of value where the lime may not succeed. The fruits vary from the size of a kumquat to that of a lime.

THE CITRON

The citron (*Citrus medica*) is a low-spreading tree, and like the lime, is very susceptible to frosts. It is not grown to any extent in California, there being but one or two commercial orchards. Some small plantings are in Florida. The tree blooms and sets fruit all seasons of the year and bears early.

The fruit is three to four times the size of a lemon, the skin quite thick and lemon-yellow in color; the pulp is scanty. The fruit is generally grown for making preserves and candied-peel or rind. Thus far it is produced at less cost in Sicily than here. The Etrog or sacred Jewish citron grows in Corfu and in Palestine. It bears small greenish-yellow fruits which if of the right size sell for fancy prices, up to $10 each.

Propagation. Cultivated varieties do not come true from seed. In Florida, propagation is effected by cuttings, layers, budding or grafting. Budding on the rough lemon stock or sour orange is practiced. Grafting is more difficult, owing to the high temperatures prevailing. Cuttings of ripe-wood root readily both in the propagating house and outside. For outdoor cuttings, well-ripened wood is cut into 6- to 10-inch lengths in December, and all leaves but the top one are removed. The cuttings are planted up to the top leaf in well-drained soil, given shade, either of lath or brush, and kept well watered until the rainy season. They are usually rooted by the following November. For inside work, short cuttings 2 to 3 inches long of ripe wood are started in moist sand during winter or early spring. A larger percentage of rooted cuttings is secured than by the outdoor method. When rooted, the cuttings are transplanted and grown in the nursery row to good sized trees. Layering is done by pegging down a branch during the rainy season. The tree resulting is not so symmetrical as that secured by budding or from a cutting.

Soil and location. A well-drained soil in good tilth will satisfy the citron. Like the lemon, it prefers a rich, easily worked, light loam. In addition, the site of the orchard should furnish not only good soil but the best of air drainage. An abundance of sunshine and freely moving air will do much to keep the plants in health and enable them to resist or overcome many of the troubles to which citrus fruits are heir.

Orchard management. The trees are set about 15x15 feet. In Corsica the trees are kept low and vase-shaped and are handled like lemons. The planting is as described for orange. The tree is apt to be low growing and make long lateral branches, which may extend to the ground and take root, thus rendering cultivation and harvesting more difficult. Cultivation consists of shallow plowing in December with thorough cultivation in spring up to June to keep a good mulch. An application of fertilizers is made in December. A cover crop is seeded after the rains set in in summer to provide humus. The sandy soil of Florida requires this.

Harvesting and shipment. The fruit is harvested as soon as it reaches an adequate size. Production is as yet somewhat limited. The fruit is usually processed, which consists of cutting the fruit into two parts, removing the seed and pulp and boiling the rind in brine; as a last step it is candied. Each half is wrapped in tissue paper and shipped 20 pounds to the box.

THE SATSUMA ORANGE

The Satsuma Orange (*Citrus unshiu*) is a small, spineless tree. It has a dwarf-spreading habit of growth and is a regular and early bearer. It is commonly grown in Japan, and is one of the most hardy of edible citrus fruits. It does not make a congenial union with the sour orange. It may unite with it but the trees die. It can be grown on the sweet stock but it is unproductive, the fruit is of poor quality and the tree is not hardy. It grows at its best on the trifoliate stock, and on this stock it can be grown in much of the Gulf Coast region, where all other citrus fruits but citranges would fail to survive. In soil requirement the tree has idiosyncracies. It does not do well on light sandy soils or on black waxy soils with a marl subsoil, upon which the trifoliate stock fails. For the black waxy limestone soils of Texas it should be worked on the Rush citrange.

THE CITRANGE

The citrange is a hybrid between the common orange and the hardy trifoliate orange. These plants when dormant can withstand temperatures of 10 to 16° F., but so far they have not proven to be of commercial value. For home use in the southern portion of the cotton belt, this plant may find a place. The fruits are used as a source of juice for making beverages.

THE CITRANGEQUAT

The citrangequat is a hybrid of one-half Kumquat, one-fourth common orange and one-fourth trifoliate orange. The plants frequently grow larger than any of their parents. The fruits average larger than kumquats. The plants have the hardiness of the citrange and dormancy in spring which these plants lack, hence can be grown farther north. They have withstood 12° F.

without injury, are evergreen and immune to citrus canker, and it is hoped may be suitable as stocks for the Satsuma orange. The fruit is used for marmalade and the juice for ades.

THE TANGELO

The tangelo is a hybrid between a tangerine orange and a grapefruit. There are many fruits of this origin. The first one, Sampson, was a hybrid resulting from crossing the Dancy tangerine with a Bowen grapefruit. It is being grown to a small extent on a commercial scale. It ripens late, sometimes becomes partly dry before it is mature, is of medium to large size, thin skinned, good sprightly acid flavor and orange-colored pulp. The Thornton is rough skinned, ripens earlier, is less acid. It is like a tender, good-flavored orange. It is of commercial importance. There are hundreds of crosses between tangerines, king, satsuma and other kinds and grapefruits and pummelos. Tangelos exist in profusion. Some are of great promise; they are markedly variable. Those which are hybrids of the canker-resistant mandarin oranges with canker-resistant pummelos, if they prove to be as canker-resistant as is expected may be of value in regions where citrus canker (*Pseudomonas citri*) is prevalent.

THE KUMQUAT

The kumquat or kinkan (*Fortunella spp.*) is an evergreen plant formerly classed with citrus fruits, to which it is closely related. It usually makes a shrub attaining a height of 10 to 15 feet and about the same distance in width. The flowers are white, sweet scented, but the first formed have no pistils and set no fruit. Later the flowers are borne singly or in clusters of three to four on shoots which are made on the first growth in spring. There may be one or two successive growths of this bloom. These all set fruit so that the period of ripening may be prolonged for several months. The fruit is oval or round and orange in color. It has been grown in Florida since 1850. Later it was introduced into California, and is also now grown in the Gulf Coast states. In dormant condition the plants withstand a temperature as low as 15° F. In Northern Florida they are grown out of doors and as far north as Augusta, Ga.

Varieties. The two common varieties are: Marumi, a round-fruited variety, and Nagami, which is oval.

Soil. The soil best suited to the Kumquat is a light sandy loam. The plant will, however, grow wherever the orange and the lemon thrive, and is more hardy than most of the citrus fruits.

Propagation. The plant grows most vigorously on a stock like rough lemon. It is also grown on sweet orange stocks. When grown on the trifoliate orange, which is frequently preferred on account of its hardiness, it makes a bush well adapted to indoors or outside. This stock is used for potted plants, the plant being quite attractive with its fragrant white flowers and its fruit. Shield budding is usually employed.

Planting and culture. The usual distance is 10x10 feet to 15x15 feet. Sometimes they are planted in hedge fashion, rows 15 feet apart, plants 6 feet in the row. Cultivation is given as outlined for other citrus fruits. Fertilizers may be necessary to insure strong growth. It is important that the early growth made in spring be vigorous, for it is from this that the fruiting buds are formed.

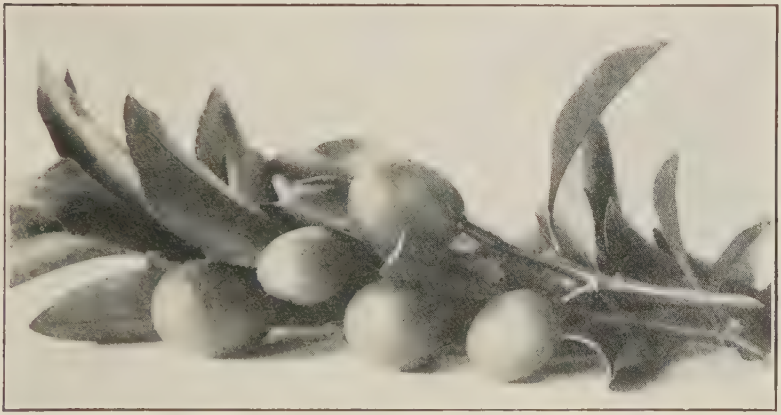

FIG. 149. Fruiting branch of Kumquats

Calif. Agr. Exp. Sta.

Pruning. The plants are liberally pruned before they start into growth. This induces stronger growth of the remaining twigs, resulting in an increase in size and quantities of fruit. Pruning is usually severe, especially during the winter months. In addition, the mode of gathering the fruit insures a certain amount of pruning for the fruits are clipped from the plants with the leaves and twigs attached. If the crop is light, additional pruning can be given.

Shipping. The fruit is usually shipped in strawberry baskets. The bulk of the movement is timed for the holidays. The fruit is generally eaten out of hand. It is also used for marmalade, jellies and crystallized fruits.

Australian Desert Kumquat *(Eremocitrus glauca)*. This small shrub or tree is the hardiest of our evergreen citrus fruits and possesses considerable drought-resisting ability. It bears edible fruits. It can be grafted on other citrus fruit trees, or be used as a stock for same.

PART XI

TROPICAL AND SUB-TROPICAL FRUITS OTHER THAN CITRUS

CHAPTER LVIII

THE AMBARELLA AND ITS RELATIVES

Ambarella, Otaheite-Apple (*Spondias cytherea*). This is an erect tree which may attain a height of 30 to 60 feet. It bears fruits of the size of a plum to that of a lemon, deep golden color when ripe, with a thin, tough skin which envelopes soft, juicy yellow pulp. In a fruit 3 inches long, the seed may be about 1½ inches long; the seed is large, is usually oval and is covered with long, woody spines. The flavor of the pulp is sub-acid, and suggests that of the apple, but in some cases it is disagreeable and resinous. The fruits are rich in sugar and are used for making jams and jellies, but as yet it is not regarded very

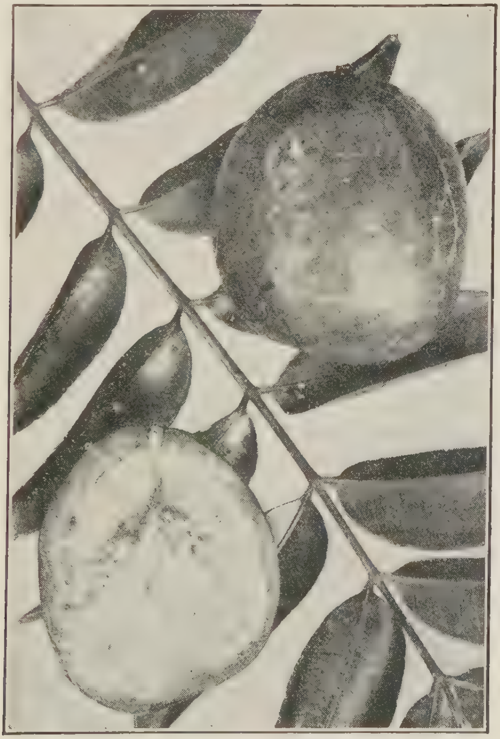

FIG. 150. The Ambarella
Wilson Popenoe U. S. D. A.

highly. The plant is grown successfully in Southern Florida and does very well at Miami. It seems to be too tender for California, except in the most favored sections. It does well in pots.

This plant and most of its near relatives are propagated by cuttings which are frequently set in a permanent location immediately upon removal from the parent plant. Seedlings may be raised by planting the seeds in flats of light soil, covering them to a depth of 1 inch. They may be expected to germinate in four to six weeks. There is considerable room for improvement in varieties by the selection of seedlings and the propagation of the best. The plant does not seem to be fastidious as to its soil requirements.

Red Mombin, Spanish Plum (*Spondias mombin*). This fruit tree is grown successfully in Southern Florida, but has not yet fruited in California. The tree is much smaller than the Otaheite-apple. It drops its leaves during a portion of the year. The fruit is small, frequently about an inch long, is usually purplish-red in color and has a very juicy, bright yellow pulp of sub-acid flavor. Some of the varieties are quite desirable for eating out of hand. A rich, moist, fairly heavy loam is preferred. The plants are propagated by means of cuttings. The trees are set 25 feet apart in good soil, 20 feet in poorer soil. No horticultural varieties have been developed.

THE IMBU

The Imbu (*Spondias tuberosa*). This plant is a native of the dry land in the interior of Northeastern Brazil. It has tuberous roots which render it well adapted to an arid region. It bears fruits the size of large plums, which have a pale yellow skin resembling a green gage plum, soft juicy pulp, and a large, nearly smooth seed. The flavor is quite agreeable, like that of a sweet orange. It is used for eating out of hand and for making jellies and custards. It is being tried in various southern parts of the United States and is perhaps the best of its genus, and merits cultivation wherever it can be grown.

Yellow Mombin (*Spondias lutea*) is inferior in quality to the Red Mombin. It succeeds in Southern Florida, but is not common.

CHAPTER LIX

THE AVOCADO

This evergreen tree (*Persea spp.*), a native of the tropics, is now grown in Southern Florida, along the Gulf Coast and in Southern California as far north as Los Angeles. It is a most promising fruit in these areas. Wilson Popenoe regards the Miami limestone belt on the Florida East Coast from Fort Lauderdale southward as ideal, especially the reddish clay soils south of Miami. In commercial varieties, the fruit is large, round, oval, oblong or pear shaped with either a green, yellowish-green or russet to deep purple, and sometimes black skin; inside is a firm yellowish-green pulpy flesh which is of high food value. There is a single large black seed.

The tree usually reaches a height of 25 to 40 feet. Seedling trees may attain a height of 60 feet, but budding dwarfs them. A seedling tree seven years from the seed may have a height of 20 feet with a spread about the same and a trunk 3 inches in diameter. A tree thirty years old of a free-growing type may have a spread of 45 feet and a height of 40 feet. The tree usually begins to bear the third year from seed. A prolific tree of 20 feet height and 20 feet spread at seven years old has borne 400 fruits. An eleven-year average of a tree at ages twenty to thirty was 518 fruits, and it began to bear at five years of age.

Variety notes. Certain varieties, as Northrop, produce two crops a year, a large fall crop in September to November and a small one in spring. The White at Santa Barbara shows a tendency to bear three or four crops a year. By planting several varieties, fruit can be had throughout the entire year. From bloom to ripening of the fruit varies from seven months to over a year, some varieties carrying bloom and fruit at the same time. Cross-pollination is essential with many varieties. Self-sterility and incompatibility exist with a number of varieties. Varieties adapted to each other must be planted.

The Ganter tree at Whittier, California, is insured for $30,000 and has turned in its owner an income of $3,000 a year for two years from its fruit and the budwood sold, about half the amount being from each source. Bud variation exists in Ganter and other varieties.

Composition of Avocado fruits. The fruit varies markedly in composition. The variety Chappelow is very high in fat, running over 29 per cent fat; 1.4 per cent protein; 51 per cent water; 77 per cent of the fruit being edible. In marked contrast with this is Solano, which contains but 3.85 per cent fat; 1.27 per cent protein; nearly 91 per cent water; 84.5 per cent of the fruit being edible. The variety Trapp, which is one of the most extensively grown in Florida, is low in fat, with but 9.8 per cent, but has a very pleasant, nutty flavor, hardly a trace of fiber in the flesh and has a thick skin. It is a prolific bearer, of yellowish green, smooth-skinned, almost spherical fruits.

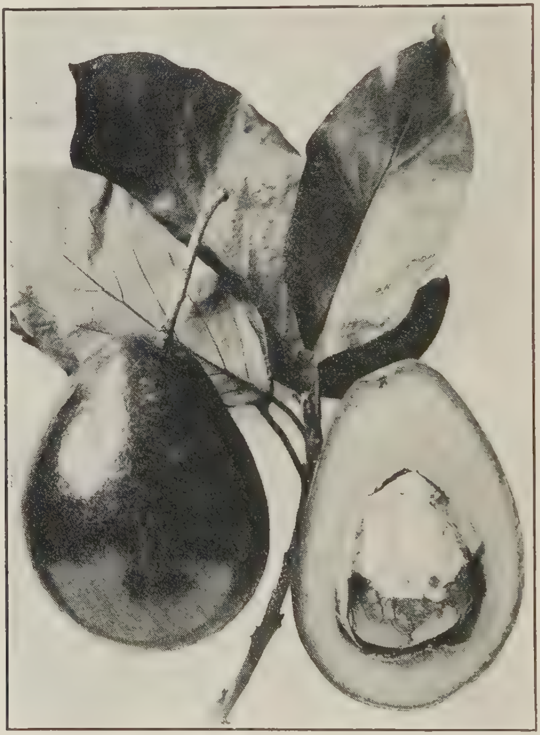

Fig. 151. The Butler Avocado. An excellent variety of the West Indian type. Size about a pound. Color of skin light green; flesh yellow, of excellent quality. A regular and prolific bearer, ripening its fruit in late summer. Originated at Miami Plant Introduction Garden *Photo by E. L. Crandall, U. S. D. A.*

Climate. Since some of the varieties of Avocados have been grown for centuries in Mexico at elevations of 6,000 to 7,000 feet, where they have been constantly exposed to severe frosts and others have been grown in the tropics, it follows that there are varieties adapted to a wide range of conditions. Some plants may endure temperatures of 20 degrees when mature, while others are injured at 27 or 28 degrees. The hardy varieties are as hardy as the orange, but this tree will not endure extreme heat.

The heat of the Imperial Valley is too great for the foliage. It cannot endure very windy locations, and many parts of California are too windy for it. Southern Florida from Miami south promises to be suitable for the crop. Further north the plants should be given protection in the winter, while young. This may consist of burlap, cornstalks or palm leaves wound around the plant. Where irrigation is practiced it should not be given late in the season, thus aiding maturation of the plant tissue. When mature they will survive temperatures which would destroy them while they were young. In California, the crop is usually irrigated. In Florida irrigation is not commonly practiced but it is realized that a wet spring is usually followed by a good crop, and a dry one by a poor crop (the reverse of the mango). In some parts of Florida when the rainfall is below normal, irrigation may be resorted to. The amount of water required is equivalent to a rainfall of 35 to 40 inches. Humidity is an important factor. In parts of California the climate may be too dry for the crop. This is not so important in Florida.

Soils suitable for citrus fruits which are deep and well-drained are desirable. Good drainage is particularly desirable. Heavy clay and adobe soils can be used, provided the drainage is good.

Propagation. The Avocado is budded on seedlings. The stock is an important factor, and deserves further investigation. Some are congenial, others not. The seeds retain their vitality for several weeks after removal from the fruit. They are usually planted as received, in flat boxes or pots not less than 4 inches in diameter, and preferably in a light, porous soil, relatively rich in humus. The seeds are usually planted with the pointed end up, leaving the tip projecting above the surface of the soil. Sometimes the seed is covered with 1 inch of soil. The pots are placed in a frame with straw or litter packed around them, in a glass house if necessary, or in a slat or lath cover. The straw or litter between the pots is kept moist. Germination takes place in two to four weeks under favorable conditions. The young plants are transplanted from the pots to the outside nursery when 6 to 8 inches tall, since the pot-grown plants are not wanted. Commercially in most cases the seeds are planted out of doors, 14 inches apart in rows 3 or 4 feet wide. They are covered with 1 or 2 inches of light soil, or perhaps with a mulch of straw and watered daily. In California, seedlings of the Mexican race are preferred as stocks, since they are hardier than the thick skin race; the seeds often sell at 4 or 5 cents each.

Nursery practice. The young plants are gross feeders; and the soil should be rich. They are usually budded when three-eighths-inch diameter or even less. Shield budding is generally used. The buds are cut large, at least 1¼ inches in length, and are usually cut with a small portion of wood under the eye. If the stock is over large, say three-fourths-inch in diameter, the buds should be not less than 2 inches long. To cut such a bud, the stick will need to be three-eighths-inch diameter. It is important that the knife be kept extremely sharp and that the bark slips well. The time at which budding can be most successfully done, depends upon the location. In California, May and June are usually advised, although buds are inserted until fall. In Florida, late autumn and winter budding is practiced, frequently in October. The buds stay dormant during the winter. In Hawaii, winter and early spring are preferred, although budding may be done any time the bark will slip. It seems that there are times which are more favorable than others, and these are matters of local knowledge. Thus in Trinidad, stocks budded when 4 months old, gave 94 per cent stand of buds; those six months old gave a 58 per cent stand with an average of 74 for stocks between these ages, while stocks ten to twelve months old gave a stand of but 17 per cent. The variety is an important factor.

Selection of bud wood. The buds are apt to drop off if the bud sticks are too mature, making a blind bud. The ideal bud wood is of recent growth, but sufficiently hard so that it will not snap on bending. It must have plump, well-developed buds. Some advise that wood which is varying from tender to mature, but which is still green and smooth, should be chosen. Some varieties do not bud well. Challenge, Dickey, Murietta are in this class, while Taft and Fuerte are relatively easy to bud.

Tying the bud. The bud is usually tied with waxed tape or twine, the eye being left exposed. The buds should unite in three to five weeks, when the tape should be slackened. The tape should be left in place until the bud has made 3 or 4 inches of growth. Sometimes the bud is forced into growth by girdling the stock 3 to 4 inches above the point of union, or by cutting it off about a foot above the place where the bud is inserted. The stocks should be gone over every week, and all adventitious buds removed. When the bud has grown 8 to 10 inches the stock is trimmed back close to the bud and coated with paint or grafting wax. It is possible to tell whether the bud will grow in a couple of weeks after budding. If it is a failure the stock should be re-budded. The tree is trained to a stake in the nursery row, and may grow 5 feet tall in seven months of growth.

Planting. Budded trees are grown one year and transplanted the following spring. The plants are usually balled. In Florida trees that are carefully handled and moved between flushes, and defoliated and pruned, may be transplanted with bare roots. Planting with bare roots is not advised for California. The top is pruned moderately. Sometimes the plants are grown in pots so that they can be transplanted without injury to the roots, but this is not commercial. A common distance in Florida is 20 to 26 feet apart; in California 24 to 30 feet apart, for strong-growing varieties, as Fuerte, Spinks, etc., and in the case of seedlings 30 feet at least. Some wide-spreading varieties may be given 60 feet each way. Interplanting of upright growing varieties, as Lyon, for fillers is practiced in California.

Top-working. Some orchardists favor the planting of strong growing trees in the orchard and top-working these to the desired variety. This entails a loss of eighteen months. Buds cost 2 to 10 cents each and one-year-old trees, field grown, $2 to $5 each. Unproductive or undesirable seedlings may be top-worked either by grafting or budding, budding preferably. The tree may be cut back severely in spring, leaving stubs 3 to 4 inches in diameter, the cut surfaces of which should be covered with grafting wax. From these stubs numerous sprouts will start, three or four of which should be left on each branch. When they have attained a diameter of three-fourths inch, they may be budded. Care will have to be taken that the wraps are not left too tight on the bud, since growth is apt to be made quickly. In large trees the stubs of branches have been grafted, using long scions and giving special care in the work. The growing scions will need staking until several feet long and well hardened. The trunk of the tree may be whitewashed. Congeniality of scion and stock is an important factor.

Time of planting. December to February in California are considered suitable months. Trees planted in March may be injured by late frosts. Fall planting in November is sometimes practiced. In Florida, fall planting during late September and October is preferred, after the hottest weather is over. If a spring planting is made, say in March to May, the plants must be kept well watered and in California are sometimes protected by lath screens until they harden.

Cultivation. In California, the treatment so far given has been similar to that advised for citrus fruits. It must be shallow. Deep tillage is apt to cut off and destroy the feeding roots. In dry climates, irrigation is resorted to, especially during the early life of the plant, and it should be regular and frequent and withdrawn in time to permit the tree to mature its wood. In Florida, the use of a mulch of weeds, straw, litter, seaweed or other coarse material is desirable and should be maintained throughout the year. The mulch should extend beyond the spread of the branches.

Pruning. The tendency of seedling trees is to grow upward and not to spread outward; hence heading back has been the practice. The tree should be low-headed (about 30 inches above ground level) with a wide spread. So headed, there is less damage from winds, and the fruit is easier to harvest. All weak limbs and unshapely ones are cut out. All wounds should be protected with grafting wax or bordeaux paste or wound paint to prevent the entrance of fungi. In California the recent tendency is to do as little pruning as possible and thus encourage early bearing in the case of young trees. With mature trees in Florida, late fall and winter pruning, from November to February, is advised. In California fall or early spring is deemed best. Pruning in hot weather is often followed by serious results. Girdling is on trial as a means of making barren trees fruitful. In California it is usually done in October and consists of the removal of a ring of bark one-eighth to one-quarter of an inch in width at the base of the limbs. It reduces the vigor of the limb and the roots.

Fertilizers. The growth of young trees is much encouraged by the use of fertilizers furnishing organic nitrogen. The growing of leguminous cover crops in the orchard for the purpose of enriching the soil in humus and nitrogen is to be encouraged. The velvet bean is a good cover crop. From 3 to 10 pounds per tree of a fertilizer mixture containing 3 per cent nitrogen, 5 per cent phosphoric acid and 12 per cent potash has been suggested for bearing trees and it is recommended that the fertilizer be applied in small doses during the growing season.

The fertilizer requirement is similar to that of citrus although ammonia from an organic source seems more suitable than that from an inorganic source. During the war potash was not available and in Florida no trouble was experienced due to this omission. One Florida grower advises that three or four applications of fertilizer be made annually, one a heavy application after the crop has been picked and a lighter one in February to aid them while in bloom. For ten-year-old trees as high as 25 pounds of fertilizer have been applied at one time. One formula which proved satisfactory analyzed 4 per cent ammonia, 6 per cent phosphoric acid and 2 per cent potash, made up from cottonseed meal, castor pomace, tankage and ground tobacco stems.

Diseases and insects. Wither-tip (*Colletotrichum glœosporioides*) is a fungus which is apt to attack the plants in Florida. The remedy is to apply bordeaux mixture. In California, the black scale (*Saissetia oleæ*) is sometimes serious, so that combative measures are necessary. In addition, two or three scale insects sometimes attack the tree, but have not yet proven serious. In Florida, thrips cause damage and are checked by spraying with nicotine solutions. Red spiders also do damage and are controlled by spraying with distillate emulsion or lime sulphur or dusting with dry sulphur.

Avocado varieties. Over eighty varieties have been named and propagated in California and a somewhat smaller number in Florida.

Size of fruit. The following standards have been fixed: Very small, below 5 ounces; small, 5 to 8 ounces; medium, 10 to 14 ounces; large, 16 to 19 ounces; very large, 19 to 24 ounces, and extremely large, above 24 ounces.

Classification of varieties. The varieties are frequently spoken of as thick-skinned or thin-skinned, according to the kind of skin the fruit possesses, but this does not tell the story. The skin may be soft and no thicker than that of an apple or it may be a woody granular shell one-eighth inch thick. A better division is into two species and three races.

1. *Persea drymifolia*, in which the foliage has a characteristic

anise-like odor and taste. The Mexican race includes the hardy, small, thin-skinned varieties grown in California and the Mediterranean, as Chappelow, Gottfried, Puebla, Northrop, San Sebastian, Topa-Topa, White, Azusa, Carton, Walker and Dickey. These may be grown where oranges thrive.

2. *Persea americana*, or plants not having the anise odor and including (a) The South American or West Indian races, including most of the varieties at present grown in Florida, as Trapp, Pollock, Barker, Family.

(b) The Guatemalan race, in which the fruits have very thick, woody skins and ripen from late winter to mid-summer. This is the time the fruit is highest in price. Varieties of this group are Rita, Dickinson, Nutmeg, Nimlioh, Queen, Eaglerock with Fuerte and Lula hybrids of this race. These usually succeed in climates where lemons thrive, although some varieties are not as hardy as lemons.

Trapp is the only variety which has been extensively planted as yet in Florida. Pollock, which ripens in Florida during August and September, is planted to a small extent. It is desirable to have varieties which ripen at different times so that a supply of fruit can be had all through the year for the local market. This is now possible in California for ten months out of the twelve. It is important to have the bulk of the commercial crop in the winter, for then the northern markets will pay the most for it.

Among thin-skinned varieties favored in California are Ganter and Harman in green-skinned and Chappelow, Northrop and Carton in purple-skinned. For commercial planting the larger, hard-shelled type is sought as Taft which is slow in coming into bearing; Lyon, Blakeman, Challenge, Sharpless, Meserve, Fuerte, Spinks and Linda, are also regarded favorably. The leading variety in Florida is Trapp. Pollock is probably second in importance, but both are somewhat susceptible to frost. Other varieties grown to a limited extent are Family, Rico, Blackman, Wester.

Points of a variety. In examining a variety the following points are of importance:

1. **The tree.** It should be precocious, but not so precocious as Lyon, which is apt to bloom in the nursery row; prolific and a regular bearer; sufficiently hardy to withstand ordinary frosts. It should be capable of being budded and when so propagated should develop into a vigorous, upright tree, before it starts into bearing.

2. **Bloom.** It should come into bloom late enough in the season to escape heavy spring frosts.

3. **Fruit.** In size and shape the fruit should be uniform; oval or round is preferable. About a pound in weight is best. The flavor and quality should be good. The seed should be small and fit tightly in its cavity. The skin should be of such texture that the fruit can be shipped safely.

Harvesting. Orange clippers may be used to harvest the fruit, the fruit being severed just above the swollen portion of the stem. Since ladders may cause injury to the tree, some use a picking bag made of heavy canvas sewed on a steel rim, which is equipped with a hook at the end for severing the fruit. The bag is attached to a bamboo pole which may be 30 feet long. One fruit is harvested at a time. Fruit for shipment must not be scratched or bruised. The fruit will ripen off the tree and may be harvested ten to fourteen days prior to being ripe, but the harvesting of immature fruit is discouraged since such fruit lacks flavor. The fruit is inedible until ripe and when ripe must be used in a few days. Trapp is usually allowed to hang as long as possible, the late fruits bringing the highest price. When bright green or yellowish-green they must be harvested or they will drop. They must be harvested so that they will not be overripe when they reach the market.

Shipment. The fruit is usually graded according to size, color and form. It is carefully packed, especially if it has to be shipped any distance. At the present time, the fruits are wrapped in strong paper, and in some cases are slipped into a cardboard cylinder. These are then packed closely to prevent shaking in light wooden boxes or crates which contain one layer of fruit. In Florida the tomato crate, 12x12x24 is used. Excelsior is used above, below and between the fruit to prevent bruising. Wrapping in tissue paper is not advised. It causes the fruit to heat and ripen. The number to a crate varies from 23 to 54, average 40 in the case of Trapp. The Pollock runs 18 to 36 to a crate. The fruit must not be crushed in nailing. For long distance shipment, refrigeration is advisable, and a temperature of 40 to 45° F. should be maintained. Temperatures below 40° F., if long continued, are apt to cause decay.

Yield. In Florida, a mature grove of Trapp yielded about 500 crates to the acre, 40 fruits to a crate. Trapp trees five years old bore one to four crates per tree, two and one-half crates being the average, with ten crates possible from ten-year-old trees. Another large grove showed an average for two seasons of one and one-half crates per tree, which is regarded as low. The trees were set 70 to the acre, and the crop averaged, in 1914, $5.25 per crate or $550 per acre income. The returns in October showed an average of $2 per crate, by the end of November prices were higher. At Christmas, prices are usually high. In this instance, the last crates shipped in February sold at $36 for 36 fruits. This will show the advantage of having the crop mature late.

The record of Chappelow variety in California is given as follows: Tree planted 1893, began to bear, 1898. Yield in 1902 was 310 fruits; fruits other years were: 1903, 380; 1904, 605; 1905, 575; 1906, 235; 1907, 465; 1908, 1,209; 1909, 260; 1910, 285; 1911, 1,023; 1912, 350; 1913, 20, (year after freeze); 1914, 3,293. This 1914 crop was harvested as follows: July, 34 fruits; August, 113 fruits; September, 1,051 fruits; October, 1,602 fruits; November, 457 fruits; December, 36 fruits. This variety blooms early, and is apt to be caught by frost, hence the variation in yield.

CHAPTER LX

THE BANANA, BAEL AND BREADFRUIT

The banana (*Musa sapientum*) is probably one of the oldest of all human foods. The plant is a native of India and China, and while it can be grown in Southern California, Florida and some of the other Southern states, it is a tropical fruit that has been commercialized. From Central America and the West Indies in normal times a fleet of steamers connect with regularly scheduled banana trains which carry the fruit rapidly to all parts of the country so that no village, no matter how small, is left without its supply of bananas. The business has been developed on one variety, the Great Michael, a yellow-skinned banana. There is a small demand for the Spanish Red or Cuban Red. The cost of production is so low and the distribution by water so economical that many doubt whether a commercial industry can be developed in this country. No fruit has been so well commercialized.

Soil and climate. A fairly rich, free-working loam soil is the most desirable. It must be fairly well supplied with lime, have a good supply of humus, be well drained and one in which good cultivation can be maintained with a minimum of cost. It is usually plowed deeply and well fitted before planting. The plants will endure a slight frost without injury. Five or six degrees of frost will destroy the leaves and fruit, but the plant will start up again. An abundant rainfall, from 60 to 100 inches, is essential. If all soil conditions are good no fertilizers are used, especially if the patch is replanted every five years or so. Under other conditions a fertilizer furnishing up to 150 pounds of potash, 75 pounds of phosphoric acid and 50 pounds of nitrogen per acre may be used.

Propagation. Most of the edible bananas do not bear seeds, hence they are propagated by means of suckers. These grow at the base of the plant. When two to eight months old after they have rooted they may be separated by means of a mattock or cane knife and planted. In Florida this is usually done in March, before the plant exceeds 18 inches in height. The top is cut off to about 6 inches above the bulb. The suckers must be handled with care and not bent. Sometimes they are piled and cured for a few weeks before planting, but direct planting as dug is perhaps best.

Root cuttings. A quicker method is to cut the whole of the root stock into small wedge-shaped pieces, leaving an outer surface of 1 or 2 inches in size on each piece. These are planted, wedge downward, in light moist soil and lightly covered with moss, leaf mold or sand. A sunny place is chosen and the plants are kept moist. If done under glass, bottom heat should be applied. As soon as these root cuttings have started one or two leaves they should be planted. Both seedlings and root cuttings need skillful handling. They need a rich soil, sufficient space and proper care at transplanting time so as to make a rapid and unchecked growth.

Banana varieties. There are several hundred varieties which differ in flavor as much as apples; some, as the apple banana, are not edible until fully ripe.

The common varieties of the genus *M. sapientum*, are the Great Michael or Jamaica, Red Spanish, Apple, Lady Finger, Ice Cream, Brazilian, Hâmakna, Largo and the Hawaiian group as Huamoa, Iholena, Maimaoli, Popoulu, etc. The *M. Paradisiaca* group bear long cylindrical fruits, which are usually eaten when cooked. Kusaie and other kinds which bear seeds belong to this group. The Chinese, Dwarf or Canary or Cavendish banana (*M. Cavendishii*), grows only 4 to 6 feet tall. The male flower persists on the top of the stem. The fruit is about 4 to 6 inches long, is of excellent flavor and has a thick stem. It is grown in Florida and in Hawaii, and is found on the California markets. This variety is resistant to the Panama disease, a fungus trouble which has been serious in Central America. The bunch is not so compact as that of the Jamaica variety and needs wrapping for shipment. Some varieties are grown for their decorative effect and one or two species are grown for the fibre, this plant being a near relation of the Manila hemp. The textile and ornamental species are usually propagated by seedlings.

Planting. The plants are usually planted in rows 10 to 18 feet apart for the tall varieties and perhaps 12 feet apart in the row; in the case of the Chinese 12 feet by 8 feet under favorable conditions. They may attain a height of 15 to 35 feet when mature. In Jamaica they are set 14 feet apart each way, although some set 10x10 feet, and others up to 16x16 feet. Two suckers are planted in each hole, the holes being dug 2 feet 6 inches every way. ''Maiden'' suckers are preferred, and these may be eight months old.

Cultivation. As soon as planted the suckers are liberally watered, and cultivation is given to maintain a dust mulch. Some growers prefer a leaf mulch, or a system of green manuring. Drought is often an important factor in reducing crop yields. Cultivation is usually given as for other orchard crops. A cover crop is grown in the rainy season which is turned under if needed as soon as the dry season comes, or is cured for hay and tillage is again started. Mulching is increasing in favor in the West Indies, Jerusalem peas (*Phaseolus trinervis*) finding favor for this purpose.

Time required before bearing. The plant is allowed to carry two or three suckers of different ages. The first crop is usually borne in from twelve to fourteen months in the tropics. Fawcett says ten months after the planting of a six to eight months-old sucker in Jamaica. A longer time is required in less favorable locations. In Hawaii it may be thirty to thirty-six months. The ratoon crop will appear in another twelve to sixteen months. The ratoon is the sucker which springs up alongside of the parent plant and is left to renew the ''walk.''

Pollination. The suckers will grow from 4 to 35 feet tall, depending on the variety. The flower stalk appears in about seven to nine months after planting, the male flowers above the female. The pollen of the Jamaica banana deos not appear to be capable of pollenizing itself. The fruits are seedless. The female flowers appear in clusters enclosed in a modified leaf. The leaves fall off, one at a time, and the flowers set and form the fruits. In Jamaica it takes two and one-half to four months after the time the flowers shoot until the fruit attains full size or is ready to cut but still unripe. The fruit is of better flavor if ripened off the plant, but is allowed to attain full size before being cut.

Pruning. Too many suckers cannot be allowed. Two or three, varying in age, may be left on irrigated land. No process in the banana walk is so important as the selection of the right sucker. Four trunks to one plant are ample. In Jamaica ratoon suckers take fifteen or sixteen months to fruiting, or longer. The thicker the shade the longer the suckers take to reach the fruiting stage. A planted sucker takes longer to fruit than a ratoon sucker because it is usually six to eight months old when planted. Four hundred and fifty stems to an acre are usually all that can be profitably grown; some people leave

600 to 700 and then have but 200 bearing fruit. Small suckers bear small bunches of little value. Seven to ten-hand bunches are needed, and these are needed when prices are highest.

Diseases. Panama disease attacks the Jamaica variety, causing the leaves to droop and the bulb to rot. It is a fungus disease. Ripe Rot Fungus, Anthracnose or Blackening (*Glœosporium musarum*) affects the ripe and ripening fruits, causing rotting. It is a fungus disease. The Chinese banana is not subject to it. Banana scab may be seen on the fruits, causing brown areas which may turn black. Spraying with bordeaux mixture is advised.

Insects and other troubles. The Beetle Borer (*Tomarus bituberculatus*) damages the banana bulb in the West Indies. A rotation of crops is advised. Fruit flies may attack the fruits. These also attack mangos, loquats, guava, etc. The Gopher sometimes plays havoc with the crop. It is controlled by placing carbon bisulphide in its holes. The wind is perhaps the most serious enemy next to drought. It is controlled to some extent by leaving strips of timber round the banana walks to break its force.

What is a good bunch? The fruits in one cluster are known as a ''hand'' and the individual fruits are the ''fingers.'' From nine to twelve fruits make a good hand. A good bunch should have at least six to twelve hands. Nine hands are considered necessary to make a paying bunch. A bunch of nine hands (usually ten to twelve) is a first; seven to nine, a second. Bunches of abnormal size, as seventeen hands, are not desired, as they are hard to ship. In most varieties as the bunch increases in size it bends downward, while the bananas turn upright. The loop in the bent stalk makes a convenient hook to hang the bunch by. In the Fehi and Kusaie varieties the bunch does not bend over.

Harvesting methods. Each banana trunk bears one bunch of bananas, which constitutes its life work; hence the usual way to harvest the crop in the dwarf varieties is to cut off the trunk 5 or 6 feet from the ground, the bunch being caught as the trunk falls. Care is taken not to damage the plants nearby. The stem and leaves are later chopped up and left as manure. The stump, 3 or 4 feet tall, is left; it gradually dries up and can then be removed. When tall varieties are grown the fruit is secured by the use of long lances or palm poles armed with broad steel blades. The stalk is half severed about 8 feet from the ground and the weight of the bunch causes it to fall over. It is then cut off and carried to the car.

Time of harvest. Prices are usually highest from March to June, hence growers attempt to plant and to develop suckers so that harvest will come during these months. Inexperienced growers may harvest the bunch too soon, in which case the fruits are too thin and are neglected. If any fruits show signs of turning yellow they are rejected. Bunches with less than six hands are too small. With small growers there are often heavy losses due to lack of knowledge in these matters. A good yield is 225 to 300 bunches per acre per year and each bunch under pre-war conditions was worth from 30 to 60 cents according to its size and other conditions. The commercial bunches weigh from 55 to 70 pounds, hence the yield is about 8 tons per acre. All fruit is sold by weight.

Duration of plantation. In some localities it is considered best to replant every three years, in others it may be every seven; while in exceptional cases good yields are secured for ten to twelve years, depending upon the soil and the amounts of fertilizer and cultivation given the crop.

Shipping. The banana is harvested every day. The fruit is harvested while green, at least two weeks before it is ready to eat and is then hung in a cool place to mature. It ripens best in this way. In Central America when word reaches the plantation that a steamer is coming, all hands go to work. The foreman or owner goes through the walk and picks out the bunches which are ready to cut. Most plantations are relatively near the water, since transportation is an important item, and a steamer will need 10,000 bunches at least.

The Jamaica bananas are shipped either laid on shelves or hung so close together that they will not rub. This applies to the loading on board ship or in the cars. Some of the steamers used transport 75,000 bunches at a time. The boats are insulated with cork, and equipped with refrigerating machinery. A forced circulation of fresh cold air is maintained throughout the vessel at all times, while in the warm regions. Warm air may have to be sent through the steamer when the vessel is in cold regions.

The banana must be kept well ventilated. While being transported a temperature of 55° F. is maintained. Special machinery has been developed to facilitate the unloading of the vessels. Sprocket conveyors equipped with pockets to hold a bunch of bananas elevate the fruit from the holds of the vessel and deposit the bunches on belt conveyors which carry them to the cars waiting to be loaded. Ships are unloaded at some of our ports in from ninety minutes to seven hours, depending upon the size of the cargo.

On arrival at destination the bananas are put into ripening rooms for forty-eight hours, and are held at a temperature of 60 to 80° F. The fruit assumes a yellow color. For express shipment in winter, the bunch is hung in light wooden paper-lined carriers, a bunch in a crate. In winter, carlot shipments may need to be heated. At certain important rail points buildings are equipped for this work.

Uses. The fruit contains 1½ per cent of protein and 14 to 26 per cent of starch. This amount of starch may cause indigestion with some people. When ripe this starch has changed to sugar and is more easily digested. Bananas in which the skin is whole but has turned black are safe and palatable and nutritious food. The pulp has become a soft, straw-colored jelly, rich in sugar and is easily digested. Bananas may be eaten raw, baked, stewed or fried. The ripe fruits may be dried. Banana flour is made from the fully grown but unripe fruits.

THE BAEL

Bael, Bel (*Ægle marmelos*), called Elephant Apple, Maredoo, Bengal Quince and Bhel is a small spiny tree, a native of Northern India and nearly related to the orange. The fruit is encased in a hard gourd-like rind, inside of which is the orange-colored transparent gummy pulp, which is used in making sherbets, conserves and "ade." The fruit has medicinal value in the case of diarrhœa and dysentery. The fruit may be from 2 to 6 inches in diameter, round, or pear-shaped. In the drier parts of Northwestern India the plant is said to endure a temperature of 20° F. or lower. It can be grown in Southern California, Southern Florida and in hothouses further north. The plant is propagated by planting the flat, woolly seeds, which germinate readily; also by root cuttings, and by budding. In budding, green or purplish, fairly mature bud sticks from which the leaves have not fallen, are cut; old.

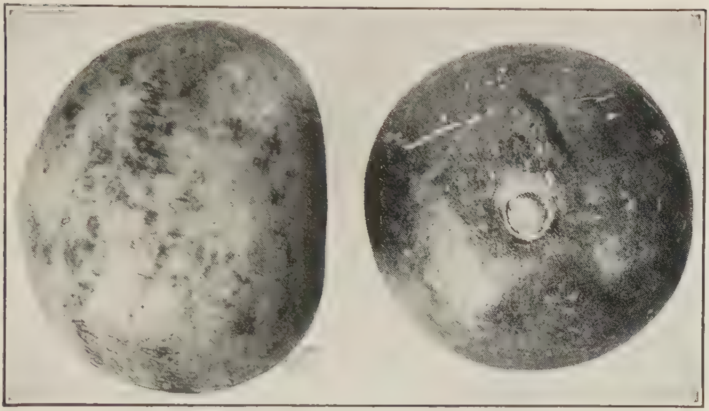

FIG. 152. Bael Fruit (*Ægle marmelos*)
Photo by E. L. Crandall, U. S. D. A.

hard, thornless budwood is not desired. The leaves are trimmed off. The buds are cut 1¼ to 1½ inches long.

THE BREADFRUIT

Breadfruit (*Artocarpus incisa*) is one of the most striking trees of the tropics and is sparingly cultivated in Southern Florida. The tree attains a height of 30 to 60 feet. The leaves are large, shiny and of various shapes, some being deeply incised, others not. The male flowers are club-shaped yellow catkins. The female flowers appear separate and are spongy and globular. The plant needs a hot, moist atmosphere, perfect drainage and an abundant supply of water. The fruit is round or globular, somewhat resembling a melon in shape. It is not capable of long distance shipment. It is eaten baked or roasted. It is ground into flour and used for making poi, and is also used in curries. Propagation is by means of root suckers and layers of the branches. The tree is related to the mulberry and the osage orange and the fruit resembles that borne by the latter.

Varieties of breadfruit. There are many varieties. The fruit of the Hawaiian type has a large stem, is round or oblong, from 5 to 8 inches in diameter, has a thick, tough, reticulated rind, green in color, which changes to brownish when ripe. The pulp is firm, mealy and somewhat fibrous, and highly esteemed. It is generally seedless. The fruit of the Samoan type is round, and has a characteristic raised rind where it is attached to the stem. The rind is yellowish-green or reticulated. The pulp is orange colored, very sweet, and somewhat sticky when cooked. Seeds are found in the fruit. In the Tahiti type the fruit is oblong, has a deep yellow pulp and very little fibre. Other types, as the Fertile variety, have smaller fruits and contain numerous large seeds which are edible when cooked.

The Jack Fruit (*Artocarpus integrifolia*) is a larger tree and demands even a greater supply of water than the breadfruit. It bears fruits on the trunk and old branches. The fruit may weigh from 20 to 60 pounds each. The oily seeds it contains are eaten when roasted and are said to resemble chestnuts.

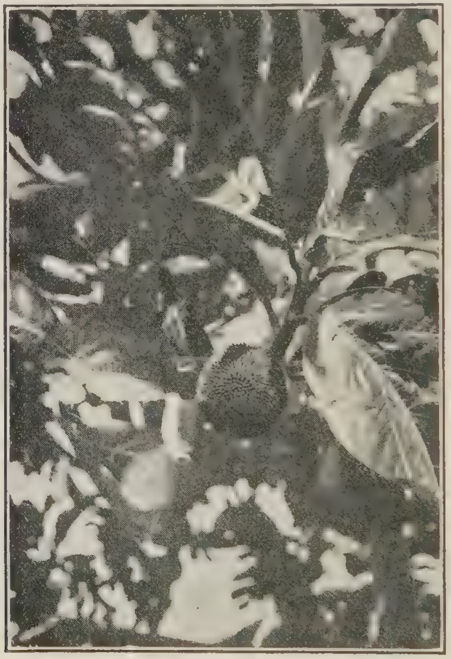

FIG. 153. Fruiting branch of Breadfruit (*Artocarpus incisa*) Costa Rica
Bronx Park Bot. Garden, New York

CHAPTER LXI

THE CARAMBOLA, CHERIMOYA AND CERIMAN

Carambola (*Averrhoa carambola*). The tree attains a height of 15 to 30 feet. It is growing in Southern Florida. The fruit varies in size from a hen's egg to that of a large orange, and bears five pronounced wings or ribs on its surface. The flowers appear on the naked stems and branches and are small rose-colored to purple. The fruit has a light yellow, thin skin, covering the watery pulp and the flat brown seeds. The tree is highly ornamental, and the leaves are sensitive to the touch. There are two types: the sweet and the sour. The flavor varies markedly in the different varieties, some being sweet, others more acid. Gathered when immature, the fruits are used as pickles. The ripe fruit of the sweet variety may be eaten out of hand or used for making jelly, sherbet or cool drinks. The sour variety makes excellent preserves.

Budding. Propagation is by budding or by cuttings. The budwood should be bearing its leaves, be fairly mature and smooth and purplish in color. Old hard budwood is not desired. Buds are cut 1 to 1¼ inches long. The age of the stock at the point of insertion of the bud is not of great importance. The trees may bear three years after planting. The flowers appear in July, and the fruit in November to December. The Bilimbi or Cucumber Tree (*A. bilimbi*) is a smaller growing tree, 8 to 15 feet tall. It bears cucumber-shaped fruits which have a smooth green rind and acid pulp, and are used for pickles.

THE CHERIMOYA (*Cherimoyer*)

This plant (*Annona cherimola*) is one of the important subtropical fruits, being regarded as one of the finest by the natives and by Europeans. There are several members of this family all of use as food producers. These are: Ilama (*Annona diversifolia*), the finest tropical cherimoya adapted to the lowlands. Pond-apple (*Annona glabra*) will tolerate wet conditions. Soursop (*Annona muricata*) is a tender species grown in southern Florida. Soncoya (*Annona purpurea*) and Custard-apple (*Annona reticulata*), are more hardy than Soursop. Sugar-apple

(*Annona squamosa*) is grown in southern Florida, but not in California. The Sugar-apple is one of the best of the group.

The Cherimoya is a small tree, reaching a height of 15 to 20 feet. The flowers often are single, or in twos and threes, while those of the Custard-apple are in clusters, which is also true of the Sugar-apple. The leaves are velvety on their under surface, while those of the Custard-apple are not. The Pond-apple, known also as alligator apple and Mangrove Annona, has glossy laurel-like leaves. The two latter Annonas are tropical, while the Cherimoya is sub-tropical.

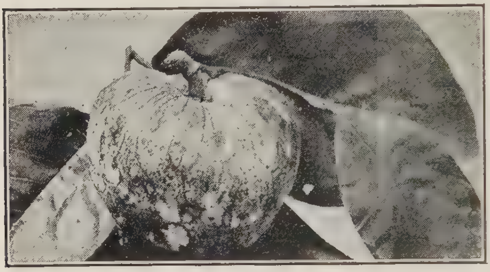

FIG. 154. Cherimoya (*Annona cherimola*). Grown at Sub-tropical Garden, Miami, Fla. *Photo by E. L. Crandall, U. S. D. A.*

Distribution. The plant has been in cultivation for centuries and is probably native of Ecuador and Peru. It is now well distributed throughout Central America and Jamaica, and is cultivated in Madeira in a small way and is doing well in Southern California, particularly in the foothills near the coast, where it promises to be an important fruit. It does not seem at home in southern Florida. It is successfully grown in Queensland, Australia, and in India and other places.

Climate and soil. This plant will not endure tropical conditions. It is essentially sub-tropical. A cool climate is needed. It will withstand a temperature of 26° F. when mature. The young plants are injured by a temperature of 29 or 30° F. Good drainage is of prime importance. Usually a good heavy loam is preferred, although in Central America the plant grows and bears abundantly on steep limestone cliffs, but most of the plants of this species will grow well on light soils.

The stock used depends upon conditions. For California, where hardiness is a prime requisite, seedlings of Cherimoya are used, while in Florida the Pond-apple has been suggested. Other congenial stocks are the Custard-apple, Sugar-apple (for a dwarf stock), Mamon, where these can be used. In Madeira, the stocks are budded or grafted at two years of age.

Budding is usually done as soon as the sap starts to move in spring. Well-matured budwood of the last season's growth is used, wood from which the leaves have fallen and from which the green color has disappeared. The buds are cut 1½ to 2 inches long; if made too small they are apt to be choked, since the bark is thick and the callus forms rapidly. Shield budding is practiced, the bud being pushed upward or downward, with great care. The buds are tied with waxed tape. In three or four weeks, the tape should be slackened and if the union is made, the stock is topped a few inches above the bud. The wrap is removed when the bud has made a few inches of growth.

Two-year-old seedlings may be grafted with a cleft graft, using scions of mature wood as outlined for budding. Well ripened wood may be used for cuttings. These are rooted under glass with bottom heat. Not widely used. Seedlings vary greatly in all characters—size, color, form, texture and quality of fruit. A large percentage are unproductive, and of those which bear, many produce fruit low in quality so that while they are of value for breeding purposes, as with most other fruits, multiplication is secured by asexual methods. The seedlings used for stocks may be started under glass or planted in warm weather, usually in flats containing a light loam soil rich in humus. The seeds are sown one-half to three-quarters inch deep. The seed may be kept several years. The plants are potted off when 3 to 4 inches tall in 3-inch pots. The soil used is a rich sandy loam in which good aeration can be maintained. When 3 to 4 inches tall, the plants may be moved into other pots or planted out of doors.

Management in Madeira. The trees are trained on a trellis, or on a wall. The plant is displacing the grape as a commercial crop. The fruit ripens best with some shade. The land is regularly manured and care is taken in the selection of varieties for their flavor, freedom from seeds and other good points. The fruits often weigh 12 to 16 pounds each. The prices received in London have varied from $1.50 each for fruits of three to eight pounds weight and $2.50 to $3 for larger ones.

Culture. The treatment given is similar to that given citrus. Budded trees are set out about 20 to 24 feet apart, seedlings 30 feet. In California irrigation is given at intervals of two to four weeks when mature and more frequently while young. Stable manure is used in California. In Queensland, an annual application of 1 to 3 pounds of acid phosphate, 2 to 6 pounds tankage and blood and 1 to 2 pounds sulphate of potash per tree has been used.

Pruning. In Argentina, the low-headed, compact trees are more productive and longer lived than tall-growing straggly trees. In Central America, heavy pruning seems to encourage productiveness. Pruning should be done after the leaves drop.

Age of bearing. The fruits are harvested when fully or "tree ripe," and are then held for ripening. If they are to be shipped, they may be packed in hay or straw in a slatted package as soon as they have attained a yellowish tinge. They should reach their destination before they get soft.

Pollination. The Cherimoya seems to be more promising for California than for Florida, but there are many unsolved problems regarding its culture. The trees are apt to be unproductive and the problem of pollination is not fully understood. The pistils are receptive before the anthers of the same plant are ready to shed their pollen, hence cross pollination is a necessity. The insect which does the work is not yet known. The unproductiveness of the plants may be due to a lack of the necessary insects.

Varieties. The shape of the fruit has been used as a means of differentiating groups or forms. For example:

Finger Print Cherimoya has a smooth surface, covered with V-shaped concave marks, resembling finger-prints in wax. It has few seeds, sweet juicy pulp and is of very good flavor.

Smooth Cherimoya is one of the finest.

Tuberculate Cherimoya is heart-shaped and bears warts or tubercules on its surface. This is a very old form. The "golden russet" variety grown in California belongs in this group.

Mammilate Cherimoya is one of the very best types grown on the island of Madeira. It is grown well in the mountains of Santa Monica, Southern California, and in India, in the Nilgiri Hills.

Umbonate Cherimoya is oblong-conic and the surface studded with protuberances. In this group, the skin is thick, the pulp somewhat acid, and the seeds relatively numerous. This form is used for making sherbets and drinks. The "Horton" at Pasadena, California, belongs to this group.

Hybrids between different species can be produced. An excellent variety has been produced in Florida by crossing the Sugar-apple on the Cherimoya.

Mountain Soursop (*Annona montana*) makes a tree 45 feet tall, so that it is quite robust, and has been introduced into Florida as a stock on which to bud the Cherimoya.

Soursop (*Annona muricata*) is one of the most tender of the Custard-apples, the common name of all Annonas. It is also one of the best of the species, being valued for its juice which is used for making drinks and for its pulp which is used for making jelly, preserves and pies. The fruits often weight 5 pounds each and are covered with an ill-smelling skin which must be removed with care in preparing the fruit. It can be grown in southern Florida, and has been grown in Miami. It grows well in Porto Rico.

Soncoya (*Annona purpurea*). Compared with the Cherimoya and Sugar-apple, this fruit lacks flavor. Popenoe states that there is no reason why this species should be cultivated when the Sugar-apple and Ilama can be produced on the same ground.

Pond-apple, Alligator Apple, Mangrove Apple, Monkey Apple, Mamon, etc. (*Annona glabra*) is usually a medium-sized tree which may reach a height of 40 feet. It grows in swampy places and will tolerate stagnant water.

Ilama (*Annona diversifolia*) is the ''cherimoya'' for the tropics as the Annona cherimoya is the fruit for the sub-tropics. This species has been introduced into Southern Florida. The fruit is favorably spoken of in Mexico and is probably the finest of the Annonas which can be grown in the tropical lowlands. The tree is small.

Common Custard-apple, Bullock's Heart (*Annona reticulata*) is essentially tropical in its requirements. Its fruit is inferior to the Cherimoya or to the Sugar-apple. The tree is deciduous, a good grower and reaches a height of 15 to 25 feet. It has been grown in Miami, Florida.

Sugar-apple, Sweetsop (*Annona squamosa*) is a small deciduous tree, 15 to 20 feet tall. It is tropical in its requirements and not adapted to the sub-tropics. The fruit is highly prized for making sherbets, but it is not used for cooking. It is less robust than the common Custard-apple and not so valuable as a stock. It is grown in Southern Florida, and it is anticipated that there it will become as great a favorite as it is in Cuba. All these species can be propagated by budding, and there is every indication that they will readily hybridize, so that the outlook for improvement and development of new and valuable types and varieties is good.

THE CERIMAN

Ceriman (*Monstera deliciosa*). This is a large creeping plant, native of Mexico and further south and is often seen in large greenhouses. It has large, much incised leaves, aerial roots, and will climb trees or creep on the ground. It may be grown in Florida, in half shade, like pineapples. It requires a very warm, moist climate for the production of fruit, and is more productive when compelled to grow on the ground without climbing.

Propagation. The plant is propagated by means of cuttings, divisions of the stem having not less than three eyes. These are rooted by planting them in pots and holding same at a varying temperature of from 65 to 85 degrees in mid-day until they root.

The flower is large white and like a calla. The fruit looks like an elongated pine cone and may be from 6 to 12 inches long and 2½ inches in diameter. The rind consists of plates or hexagonal scales which may be detached when the fruit is ripe. These are green in color until the fruit is ripe when they turn slightly yellow. The pulp is creamy-white, very sweet and has a flavor like that of a mixture of honey, bananas and pineapples. The fruit may attain full size in nine to twelve months after flowering; five or six months more are required for ripening, making fourteen to 18 months in all. The plant may be grown in a tub as a house plant, and will stand considerable abuse if not allowed to freeze, but it will not fruit under such conditions.

CHAPTER LXII

THE DATE

The date (*Phoenix dactylifera*) was one of the earliest plants cultivated by man. The date palm requires a dry, hot climate. The Arabs say it needs its head in the fire and its feet in the water. The trees are either male or female. They are long-lived and continue in bearing 100 to 200 years. They may grow 100 feet tall. The flowers grow in clusters. From six to 20 clusters are borne at one time, and each of these may produce 20 to 40 pounds of dates. The fruits are 1 to 3 inches long, yellow or red in color when ripe. The flesh may be soft and sirupy or dry and hard.

Location. For success, this plant needs to be planted where there is no frost, although some varieties will tolerate a temperature of 20° F. for a short time in winter, where the summer is hot and rainless and where there is ample facility for irriga-

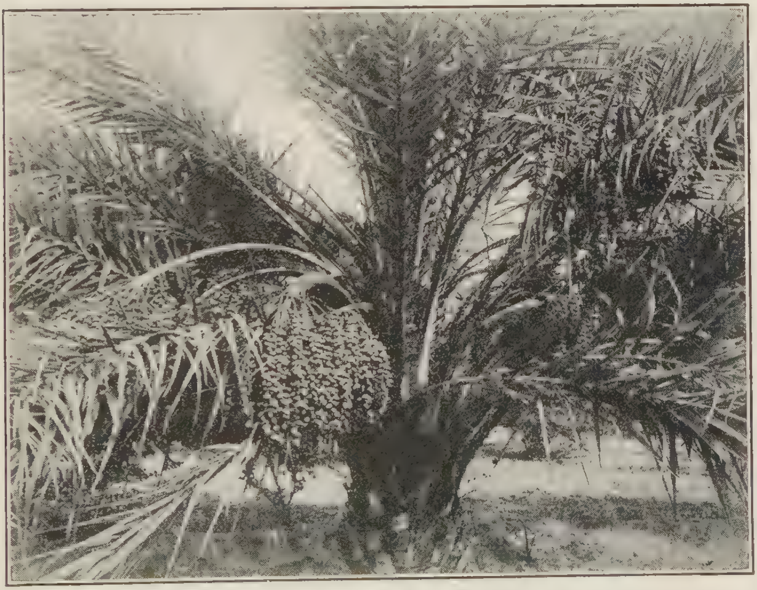

FIG. 155. An eight-year-old seedling date palm at Phoenix, Arizona. *U. S. D. A.*

tion. It needs hot, dry, arid conditions where water can be supplied. It is doubtful whether the plant can be grown commercially in a hot, moist climate, hence it is not likely that it will be grown in southern Florida, even though the plant may be grown there. Favorable conditions are said to exist in the Imperial and Coachella Valleys in California, and in certain irrigable areas of low altitude in Southwestern Arizona. The Coachella Valley has sometimes proven too dry; the fruit would shrivel on the tree unless irrigation be given while ripening. In these regions, commercial plantings are successful, although in some parts of Arizona the dew at night, or the rain falling when the dates are softening, has ruined the crops. There is a greater area in which the tree will grow, but the summer temperature is inadequate to produce satisfactory fruit, or the regions are too humid to produce fruit fit for anything but home use. In time, new seedling varieties suitable for such places may be found.

Climatic requirements. According to Popenoe, if good varieties are to be grown, the requirements are: (1) A long summer, hot by night as well as by day. (2) A mild winter, with but an occasional frost. (3) Absence of rain in spring when the fruit is setting. (4) Absence of rain or dew in the fall when the fruit is ripening.

Soil. The date may be grown on a variety of soils, but a well-drained, sandy loam soil is best. While the date will tolerate a relatively high content of alkali in the soil, the trees so located are tardy in bearing, and the fruit is inferior and unsatisfactory. Heavy soils are used in Mesopotamia, adobe soils in Egypt, sandy soils in Algeria, sandy loam in Oman and California. Thorough drainage and good aeration of the soil are desirable.

Water. Water is of prime importance. The date palm roots deeply and the soil must be kept moist to a considerable depth. Relatively large amounts of water must be applied at frequent intervals. Heavy applications are made in spring previous to bloom, and in fall just before the fruit matures. While the plant is in bloom and while the young fruits are forming, a less abundant supply is given, since an excess may prevent the successful formation of a crop.

Irrigation. The basin method of irrigation has proven satisfactory. This may be made by excavating a basin 15 feet square and a foot deep, and filling it with dry straw or mulch to prevent the evaporation of the water. This will permit the space between the trees to be devoted to growing alfalfa or sesbania. Where clean tillage is given, the furrow system may be used but care must be taken to see that the water reaches the roots of the date. When thoroughly soaked, the soil should be cultivated. Water is usually applied in the late afternoon, or at night, to prevent scalding, for hot water around the roots is injurious. Allowing the soil to bake is likewise poor policy. In the Coachella Valley, with furrow irrigation, a twenty-four-hour flow each twelve days from April to November is often satisfactory. In some instances a weekly irrigation is required. In the winter the rainfall is adequate.

Fertilizers. To maintain production, the dates must be fed liberally. Sesbania and alfalfa may be grown between the rows to furnish nitrogen, and wheat is also grown to produce humus, and the land may be heavily manured with stable manure. If not kept well supplied with plant food, a crop of dates need not be expected other than every second year.

Propagation. Seeds do not reproduce the parent plant. New varieties are secured from seedlings. Recognized varieties are reproduced from suckers which spring up around the base of the plant or on its trunk, while it is young—from four to fourteen years of age. The sucker is of the same sex as the plant it grew on. This is usually removed in spring and should be planted in a well-prepared nursery. A sucker weighing about 12 pounds, or one with a diameter of 5½ inches at its base, is probably of good size to use. One method is partly to sever the sucker from the parent plant and bank it with soil. Water copiously to induce the sucker to root, and when the roots are well formed, transplant the sucker where it is to grow. The essentials for success are: (1) A proper location for the nursery bed. (2) A hot frame which is air-tight and will contain the necessary heat and humidity. (3) Proper pruning, cutting and seasoning of the off-shoot. (4) An adequate supply of water, properly applied.

W. T. Swingle of the United States Department of Agriculture has spent much time studying this problem and has worked out in much detail the factors which enter into it. Briefly these are: That the best time for cutting offshoots in California and Arizona is from February 1 to May 1. That the inner leaves of the offshoot should be cut back one-half and the outside leaves two-thirds, four to six days before cutting. That the operation of successfully removing offshoots is very critical and should be done only by someone who has had training in the work. That a specially constructed chisel 5 inches wide on the face by 7 inches long, bevelled on the sides, and welded to a light crowbar as a handle, should be used to make a V-shaped cut to separate the offshoot from its parent, taking any roots it may have with it, but taking care not to injure the parent plant in any way. The offshoot is then seasoned by allowing it to lie on the ground beneath the palm ten to fifteen days. In this time it loses 12 to 15 per cent in weight and is then not so liable to ferment when planted. It is then planted in a specially prepared frame, in a hotbed of manure, about 8 inches deep, where it is copiously watered for the next six months. By fall, the irrigation may be restricted to once in ten days. When the offshoot has sent up two sets of leaves, which develop three at a time, and is making a third set, it is ready to move. Some plants may stay in the frame three or four years before they start to grow. Waiting is an important factor in the cost of fruit growing.

Seedlings. Seeds may be stratified in moist sand for three to six weeks to soften them, but they should not be allowed to sprout. They are then sown in the nursery row or where they are to grow. The seedlings may be transplanted at one, two or three years of age and three or four times as many plants should be set as will eventually be required. In this way there will be enough plants to permit the removal of the males and the poorest plants. The rows are usually 25 feet apart.

Varieties. The ordinary seedling date is not of sufficient value to warrant high prices being paid for it. Such dates will not compete with those which can be imported. The hope of the industry lies in producing dates of high quality, as Deglet Noor which is of large size and excellent flavor. It contains 54 to 70 per cent of sugar and will keep as it is picked from the tree. Such dates will sell for four or five times the price of ordinary fruit. Several of the best varieties of the Old World are on trial.

Deglet Noor and Maktoom are suggested for the Imperial and Coachella Valleys in California. The Halawy, the Khadrawy, and the Hayany (Birket el Hadji) are promising for cooler regions and may be planted in California for early market. Rhars is excellent for home use and Thoory is a dry date of promise in California. Deglet Noor, Halawy, Maktoom, Khadrawy, Kesba and Hayany are known to be worth planting as standard varieties. In Arizona, Halawy is regarded favorably. The adaptation of the various varieties is yet to be worked out.

Transplanting. In transplanting, the leaves should be cut back one-half three to five days before removing from the frame. The holes should be dug 2 feet wide and 3 feet deep, and filled with 12 to 15 inches of manure and 6 inches of soil and thoroughly irrigated. The palm is taken up with a ball of manure to protect its roots, and planted about 16 inches deep, as deep as possible, without danger of covering the bud. This is best done in April or May. Two irrigations a week will be needed until the plant is established. Many have advised planting from 100 to 140 palms to the acre, but this will depend upon the variety. Seedlings may be planted closely, since some of the trees will be pulled out. Much more room should be given the best varieties. A distance of 25x25 feet is suggested, but 30x30 feet is better. For such varieties as Saidy, Thoory and Tazizaoot 35x38 feet are required.

Winter protection. The newly planted palms should be protected during the first winter by wrapping with newspaper. The top is left open. At the bottom and middle it is tied loosely. If the leaves grow 12 to 16 inches while covered, it is best to prune these back one-half to reduce the leverage these have on the crown. If frost destroys the leaves the bud may start again. If the bud is killed the trunk may develop another bud at the base.

Sale of offshoots. With the best varieties, the sale of offshoots is important. The palm cannot set much fruit and make offshoots at the same time. Its tendency is to overbear. The production of offshoots takes place in the early period of life and should be encouraged with desirable varieties because there is need of plants. A four-year-old palm may be allowed to carry two bunches of fruit and should cut one offshoot and two or three the next year. At six, it may bear three bunches of fruit. When it approaches maturity, it ceases to form offshoots.

Pruning. Little or no pruning is given for the first three years. Dry and dead leaves may be removed. Two rows of leaves may be removed at four years, but severe pruning checks the formation of buds which become new offshoots. The formation of offshoots should be encouraged. After the sixth year, a regular pruning should be given in December or January of each year, but it should not go above the fruit stems of the previous year. This will leave about four rows of leaves below the new fruit stems, or thirty to thirty-six expanded leaves.

Pruning to the new fruit stems injures the fruit and often destroys the entire crop. Some advise the leaving of one offshoot on the plant so that if anything happens to it there will be a means of renewal. If the plant is left to take care of itself without pruning it would be a clump of plants. The offshoots formed while it was young would develop into trunks and such a condition is not advisable.

Pollination. The female palm blossoms from February to June, although in California in March and April nearly all the spathes (sheaths) are open. Pollen must be available at this time. Many male palms are sterile, others bloom so irregularly that they are not dependable. Fifty per cent of all seedling trees are male. They should not all be destroyed because a thoroughly tested male palm of high potency for use on any one of the standard fruiting varieties is a valuable asset. There should be at least two males to the acre, or to fifty trees. These may be planted as borders or along driveways and need not be among the females. It is better to take offshoots from desirable males than to trust to securing same from seedlings.

Early blooming males are desirable for early female blossoms. The sprays of the male blossoms may be cut off and tied above the female blossoms at the time the pollen is ripe and the female blossom receptive; or better still, the pollen may be applied directly about midday. Pollen may be saved by removing the male blossoms and placing them in a paper bag to dry and storing in a dry room with the bag open. Dry pollen may be kept ten years and it is always advisable to carry some over in case of a shortage. Dry pollen may be applied by rolling a piece of cotton in the pollen and inserting it into the cluster of female flowers, just as is done with a sprig of fresh flowers. Dry pollen may mildew and spoil if it gets damp. Rain within twenty-four hours after pollination may necessitate another application. The female flower appears to be receptive to the pollen for several days, often two weeks after the flowers open, but it is safe to apply pollen to the flowers every three days. Pollen from other palms, as Phoenix or Washington Palms, may be used if date pollen is not available.

Management. With proper cultivation, the palms will produce ten to fourteen new leaves each year and carry thirty to sixty leaves at a time. The plants may begin to bear at four to six years of age. Single ten-year-old trees have been reported as bearing 500 to 1,000 pounds of fruit, but the average yield is usually not over 100 pounds per tree, or about 5,000 pounds per acre of fifty trees. At seven to ten years old, the trees may be 20 to 50 feet tall and bear six or more bunches of fruit, which weigh 20 to 40 pounds each. At fifteen they may be in full bearing. When the plants are in bloom, sprays of the male blossoms are cut off and tied above the female blossoms at the time the pollen is ripe and the female flowers open. Since the flowers do not all open at the same time, pollen will have to be applied more than once. It may be necessary to apply it to the female blooms. The bunches of fruit are apt to be injured by the wind, hence it is often necessary to tie them to the lower leaf stalks. It is often advisable to thin the fruit for some trees are apt to overbear. This is especially true on young trees.

Troubles. The date palm or Parlatoria scale (*Parlatoria blanchardii*) has been found in Arizona. To control it, all old leaves should be cut off close to the trunk, the plants being kept well trimmed up. If scale is present the trunk may be burned with a gasoline torch or sprayed with a mixture of one gallon of cresolin, four gallons of distillate, 95 gallons of water. The offshoots may also be dipped in this solution before planting. The Marlatt Scale (*Phoenicoccus marlatti*) is more dangerous and is more difficult to handle. The spraying as above is advised. A Borer (*Rhyncophorus*) may destroy the palms. They must be watched and destroyed before they have done much damage.

Stored dates are apt to be infested by the Fig Moth (*Ephestia cautella*) and the Indian Meal-Moth (*Plodia interpunctella*). The eggs of these must be destroyed by some system of disinfection and the storages must be properly built and fumigated.

The fungus spot disease, in wet seasons, seriously injures the fruit. Bordeaux mixture and other fungicides are used. Rainy weather, when the fruit is ripe, causes it to sour and spoil.

Harvesting and sale. The dates on a bunch may not all ripen at the same time. In some cases, the ripe dates may be removed singly, but generally the bunch is cut and the dates are ripened much as bananas. The best varieties are not left to ripen on the tree. Thus far, local markets have used the bulk of the fruit grown. The commercial side may develop when the acreage now planted comes into bearing. At present, date-growing is probably one of the most hazardous of all forms of fruit farming.

Curing. Fresh, ripe dates ferment easily and cannot be shipped far. Dates which ripen on the tree are more apt to be wormy than those which are cured or fully ripened artificially. Some varieties, as Deglet Noor, fail to ripen in many places, but can be cured so that their desirable color and flavor are retained. Some varieties are rich in ordinary cane sugar, and are known as Cane Sugar varieties. In others an enzyme is present which converts this cane sugar into invert sugar, hence such are known as Invert Sugar Dates. The latter require even higher temperatures, than are found in many date-growing regions here, to invert the cane sugar and ripen the fruit, two processes which appear to go on together. The same results may be accomplished by proper curing. The ripening of a cane sugar date is a different matter from the ripening of an invert sugar date.

The advantages of artificial ripening are: (1) The fruit on the bunch does not ripen at one time. (2) The fruit can be harvested cheaply by the bunch, before the berries begin to drop or are attacked by insects, molds or bacteria. (3) The losses by rains and ravages of worms is reduced. (4) The artificially ripened fruit is cleaner and keeps better. Since artificial ripening is now understood varieties may be grown over a greater area and at higher altitudes than formerly. They may be shipped while yet hard and ripened at destination, so that fresh dates may be marketed in prime condition, which is not possible if they are ripened on the plant.

Mode of ripening. Late varieties, like Deglet Noor, which do not mature in a short season, can be ripened by holding them in a moist atmosphere in a tight chamber or box that is kept warm at night and held at 80 or 90° F. in the day time. Under these conditions the dates ripen slowly and have a light color. In the quick ripening method they turn dark colored.

Quick ripening process. The process of ripening used depends upon the variety. Briefly, the dates are placed in an atmosphere of carbon dioxide gas for eighteen to twenty-four hours and are then placed in chambers on trays to ripen in a hot, humid atmosphere for forty-eight to sixty hours at a temperature of 113 to 126° F. The fruit may be pasteurized for two to four hours at a temperature of 140 to 158° F. to destroy eggs, larvæ and insects that may be present. It is then packed in boxes. Fumigation with carbon bisulphide appears to be more satisfactory than pasteurization for varieties that are apt to be sticky. Dried dates contain 70 per cent sugar, 2½ per cent fat and 2 per cent protein. The seed is about 10 per cent of the weight of the dried fruit.

Storage. Ripe dates may be held in storage at 36 to 38° F. from two to fourteen months, depending upon the variety. When evaporated to reduce the moisture content they may also be held for several months in cold storage.

Package. Some of the fancy dates are packed in layers in one-pound cardboard boxes, and sell for high prices. Cartons should be used for the highest quality dates and no others are worth growing in the United States. Lug boxes holding thirty to forty pounds are used for bulk shipments. Varieties such as Zehedy ripen on the bunch and adhere to the thread indefinitely. Such may be handled in bunches like bananas.

CHAPTER LXIII

THE FEIJOA OR PINEAPPLE GUAVA

The Feijoa or Pineapple Guava (*Feijoa sellowiana*) belongs to the Myrtle family. It is native of southern Brazil, Uruguay, Paraguay and Argentina. It was introduced into California about 1900 and is well adapted to our conditions. This plant has been grown in southern France since 1890, being introduced by Edouard André. We may look for some varieties from that source which will be adapted to American conditions. So far, the one variety, André, has proven of value in California. The tree reaches a height of about 15 to 18 feet. Some are compact, others straggling in habits of growth. The leaves, resembling large olive leaves, have a glossy green upper surface and silvery gray lower surface. The flowers are large, 1½ inch in diameter, white outside and crimson inside, giving the tree a striking appearance when in bloom.

The fleshy petals are good to eat. The fruits may be oval or oblong, 2 inch by 1½ inch, and ripen early in winter. The skin is green with a little crimson on the cheek. Under it we find a layer of granular whitish flesh and below this a mass of pulp which contains the seeds which are so small they cannot be felt in the mouth. The flavor is described as a mingling of the pineapple, banana and raspberry. The fruits are delicious when eaten fresh, or they may be stewed, or made into pies, jellies and jams.

Soil. A good loam, rich in humus, is considered ideal. The plant does not succeed well in Florida on sandy soils rich in lime. French horticulturists claim that it will not tolerate much lime. In California it is grown on adobe, red clay and sandy loams. Some claim that heavy soils may need amelioration by the addition of sand.

Propagation. So far, propagation has been largely by seeds. The plant does not breed true from seed, and only fairly good results have been secured even when selected seeds have been used.

Growing seedlings. The damping-off fungus is one of the serious problems in the growing of seedlings. In order to get away from this trouble, the seeds are usually germinated in a mixture of silver sand and well-rotted redwood sawdust, although in some cases any light, porous soil which is not rich in humus may be used, provided care be taken in watering the plants. Germination usually takes about three weeks. The flats containing the seeds are kept in a frame and partial shade is given. As soon as the plants make two leaves, they are potted off in 2-inch pots. When 4 inches tall, they may be shifted into 3-inch pots. Later they may be transplanted. Seeds retain their vitality for about a year.

Cuttings. Plants may be propagated from cuttings. These consist of young wood from the ends of the branches, probably about 4 inches long. These may be rooted in clear sand if given bottom heat, under which conditions they may root in one or two months. They may be covered also with bell jars. Without heat much longer time is required for rooting.

Layering. In both California and France, layering is more or less practiced since it is the most certain. Branches which are close to the ground are bent down and 3 to 6 inches of their surface covered with soil, which is kept fairly moist. They are expected to take root in about six months.

Budding and grafting. In the Philippines, plants have been propagated by shield budding on seedlings. Both whip-grafting and veneer-grafting are practiced under glass. Scions and seedlings of about the thickness of a lead pencil are used. For scions, the wood should be young yet firm.

Varieties. There are several varieties, but the two most common are André and Besson.

Planting. The trees are usually set about 15 to 18 feet apart. So far, little pruning has been given. The grafted or layered trees may bear in the second year after planting. Seedlings may come into bearing in three to five years, although in many cases they have failed to set fruit to any great extent, being decidedly unproductive.

Pollination. The indications are that the difficulty in fruit production may be due in part to lack of pollination. In some cases isolated plants are quite productive and are of course self-fertile; others appear to be sterile so that if a plant is to be grown on the home grounds two or three at least should be planted together. In its native haunts it is believed that birds cross-pollinate the flowers. A bird comes to eat the fleshy sweet petals and in doing so its breast is coated with pollen which is transferred to the next plant. With the development of varieties of known habits it is possible that this question of pollination will be settled, and strains of known productiveness will be available. Self-fertile feijoas may be propagated as outlined. Seeds from self-fertile varieties may produce plants which are self-sterile.

Management. Although the plant is quite resistant to drought, in many parts of California it is necessary to irrigate. The number of irrigations needed are about the same as usually given to citrus fruits. The newly set plants are kept well watered and mulched. Soils which are deficient in humus may be manured with profit; on others the use of bone meal seems to be advisable, but a large use of nitrogenous fertilizers is not required.

Pruning. Plants of the low-growing, compact form receive little pruning. Those of straggling habits of growth may be pruned to prevent the fruit from forming too far from the trunk.

Age of bearing. Grafted or layered plants may begin to bear in two or three years after planting. Seedlings may take twice as long. In California the fruits ripen in September to December.

Harvesting. The fruits drop from the tree when mature. If harvested before maturity they lack flavor, hence are allowed to hang until the maximum of flavor is developed. They are then laid away in a cool place to reach a proper condition for eating, which is recognized by the fragrance of the odor and the slight softening of the skin. Fruits can be kept three or four weeks after ripening, which enables them to be shipped to most markets if kept cool. In a hot or humid atmosphere they are apt to spoil rapidly. So far, no satisfactory method of commercial handling of the crop has been devised because the first problem is to develop a sufficient quantity of fruit. The indications are that this will be done. Some fruits have been shipped in 2-quart baskets.

CHAPTER LXIV

THE FIG

The fig (*Ficus carica*) can be grown over a wide area. On these continents it is grown out-of-doors on the Pacific Coast from Oregon to Chile, and on the Atlantic Coast from Washington, D. C., southward. It has reached a relatively stable position as a crop in regions of the Mediterranean. There, as in the United States, it is recognized that the ideal areas are not large. For home use, the fig can be grown over an area much greater than now utilized.

Climate. The ideal temperature varies with the variety. Some varieties do well in the southern peach-growing regions and these are considered in the first portion of the chapter. Usually, varieties grown for table use do not need as warm temperatures as do those varieties grown for drying. While some varieties are more hardy, the tender varieties will not endure a lower temperature than 16° F., even when the wood is well matured. Immature branches may be destroyed at 18° F. Young trees will not endure as much cold weather as mature trees. They become hardier as they get older. When the fruit is ripening warm nights are desirable. Cold nights even with warm days cause the fruits to be dry, hard and deficient in sugar.

If the figs of Smyrna are taken as the standard for dried figs, we find that there the temperature seldom exceeds 100° F. in the shade. This temperature at the time the fruits are ripening is ample. Too high a temperature and too strong rays of sunshine are apt to bleach and harden the skin of the fig.

Water. The fig needs an ample supply of moisture. However, in a region of heavy rainfall the fruit is apt to be insipid and lacking in quality even though the tree grows luxuriantly. Natural rainfall of not less than 25 inches which falls from November to May with none during the summer is desirable; in other words two seasons—one rainy, and one dry and warm. and warm at nights when the fruit is ripening. A shower of rain on mature or nearly mature figs is detrimental. The fruits break open, turn sour and rot. Fogs are undesirable, since they prevent the proper development of sugar and injure the color of the skin. Dew is objectionable when the fruit is ripening. Figs should not be harvested while dew is on them. Warm, dry winds while the fruits are maturing, are desirable. Fig trees usually are well balanced and wind storms do not hurt them; in fact, the trees are sometimes planted as wind breaks.

Soil. Figs are grown in all kinds of soil. Figs to be eaten out of hand are less exacting in soil requirements than are figs to be dried. Warm, deep, well-drained loam soils, rich in plant food and especially in lime, are most highly esteemed. Shallow soils underlain with hardpan and bed rock do not retain sufficient moisture and the trees suffer in time of drought. On poorly drained soils the fruit is inferior in quality. On very dry soils the fruits are apt to be small and woody. Heavy clay and adobe soils are unsuitable, the fruits grown being coarse. Alkali soils check or retard the proper formation of sugar; hence the fruits grown on such may be used fresh but are not rich enough in sugar for drying. Sandy soils produce sweet figs of light color when dried, and if sufficiently rich and retentive of moisture are satisfactory. Alluvial loams, rich in lime and potash and rich volcanic soils, are satisfactory.

Figs in cold climates. The barriers to successful fig culture are short, cold summers. Protection may be given the plant in winter, but warm days and long summers are necessary for ripening the fruit. Given winter protection where necessary, there is a possibility of growing sweet, juicy, wholesome figs over most of the United States. In the North, the semi-dwarf hardy Brown Turkey may be grown for table use. Other varieties worthy of trial are Black Ischia, Brown Ischia, Brunswick, Genoa, Castle Kennedy, Marseillaise.

Figs for pots. Figs are grown in pots in parts of Europe, both for commercial and home use. A convenient size of pot is 12 to 15 inches for fruiting trees. The best soil consists of three-fourths sandy loam and the rest of it crushed mortar. The soil should be moderately rich. Liquid manure should be applied when required. The plants may be re-potted in October just before the leaves fall and should be carried during the winter in a cool house free from frost. They will start into growth if given a temperature of 50° F. which may later be increased to 60° F. They may be grown in the pots in the north and be put out-of-doors as soon as the temperature reaches

75° F. When the shoots are about 3 inches long, they may be pinched back and checked. This pinching will force new shoots, upon which the young crop of figs may be grown. During the growing season they should be given all the sun that is possible. Weak growths may be cut off close to the stem. While carrying their fruits they should be maintained at as uniform a temperature as possible, otherwise they are apt to drop their figs.

Figs for forcing. The best varieties for forcing are: Early Violet, White and Brown Ischia, Marseillaise, Hirta Dujapon and Negro Largo. For training against walls the standard varieties are: Brown Turkey, Marseillaise and Brunswick. For growing in pots or forcing, the plants must have considerable air and plenty of moisture until the crop is set. A good loam with plenty of top dressing is perhaps the best soil.

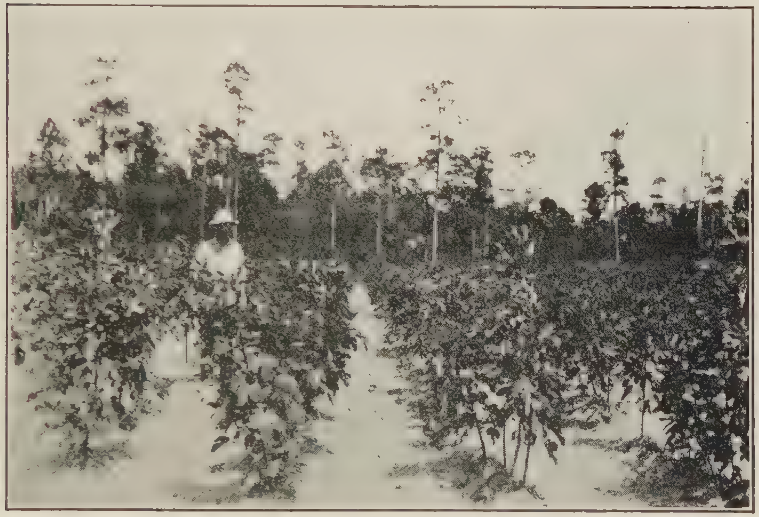

FIG. 156. Brown Turkey Fig cuttings in a Florida nursery. Photograph taken in September. The cuttings were planted the preceding spring and will be ready for permanent planting in the late autumn.
U. S. D. A.

Propagation. Figs are usually propagated from cuttings in much the same manner as grapes. Cuttings should be taken in the fall. Well matured wood of the previous season's growth is best. Long, slender shoots are not desired. At the buds the twigs are solid, hence it is always desirable to make the cutting with termini just above and below a bud. If much space be left below or above the bud it will be seen that the wood is hollow and such is liable to induce decay. Cuttings are usually made 8 to 10 inches long, depending upon the distance between the nodes or buds. Single-eye cuttings may be used but such may need to be started in a frame. Usually, the cuttings gathered in the fall are stored during the winter in moist sand or moss and held dormant until early spring, at which time they are planted in nursery rows.

Planting in the nursery. The furrows are usually 6 to 8 inches in depth. The cuttings are placed in these 8 to 10 inches apart, the depth being governed by the length. One bud is allowed to remain just above or even with the surface of the ground. The soil is then packed tightly about the cuttings. These are allowed to make one, and in some cases, two years of growth before being dug for planting.

Planting. In the Southeastern and Gulf states, the trees are usually set 10 to 15 feet one way and 12 up to 20 feet the other. In Texas, the trees are planted 16 to 20 feet apart, but when planted in a section where the trees are apt to be winter-killed, so that their size is restricted, they may be set 10x10 or 15x20 feet. In more favored regions they may be 20x20 feet. Some growers advocate 25 feet each way and up to 30 feet apart for Smyrna figs. With figs, as with most fruits, the spread of the roots is very much greater than the spread of the top, and this point should be taken into consideration.

In the several states along the Gulf coast, January and February seem to be the favorite months for planting. Further north, later in the season is preferred. Care should be taken to prevent the roots from drying out. The ground is usually well prepared before planting. The hole dug is made of sufficient size to accommodate the roots without bending them from their normal position. Trees are planted about an inch or two deeper than in the nursery. The soil should be packed tightly around the roots.

Pruning. Outside of California the general practice is to treat the tree as a bush. It is the exception to try to make small trees, the usual course being to allow three or four trunks to be made. To induce this, the tree is cut back at the time of planting. The advantage of the bush is that in the case of winter injury there are three or four trunks, so that there is opportunity to start the tree over again in the bush form which cannot be done in the tree form. There are relatively few trees along the Gulf coast that have not been killed back seriously at one time or another by low temperatures. There is a strong tendency to send up sprouts from the roots which must be considered in pruning. In the removal of branches it is advised to cut back entirely rather than to stubs. It is generally recognized that severe pruning of the fig is not desired, and that heavy pruning cannot be continuously given. Growers prefer to do as little as possible annually during the dormant period, preferably after the coldest portion of the winter is past and before growth starts in the spring.

Points worth mentioning in pruning. Decay is apt to follow pruning, hence cuts should be made so that they will heal as promptly as possible. The objects to be attained in pruning are to admit sunlight, to keep the plants within bounds, to remove dead wood and interfering branches, to render harvesting of the fruit easy and to maintain the maximum of economy in cultivation and harvesting of the fruit. Under eastern conditions the fruit is borne usually in the axil of the leaf on wood of the current season's growth. As new leaves start, the fruits appear in the axils of the leaves. Hence one of the objects in pruning is to maintain a certain amount of new growth in order that there may be adequate bearing surface. In some cases, heavy cutting back of trees is advised in order to stimulate the more vigorous growth of fruit-bearing wood. The variety is an important consideration. For instance, Celeste requires slight pruning but it should be given annually. The variety Magnolia, which is grown on the Gulf Coast of Texas, is usually pruned much more severely, a system of renewal being frequently adopted by the growers in which the branches are cut back each dormant season to mere stubs 1 to 2 feet from the ground, the growers contending that the new growth induced near the ground bears fruit which is larger and better than that borne by trees less heavily pruned. This, however, represents the extreme practice. Some growers prefer to maintain a four-stem bush, and give this moderate pruning to hold it in shape. All stages are observed, from the single stem tree to bushes with seven or eight stems, according to the ideas of the owners.

Pruning the young tree. The young tree as received from the nursery, may consist of a whip, or it may be branched. In some cases, a variety such as Celeste may be heavily branched, while the variety Magnolia and some others, just a whip. The usual procedure in the case of a whip is to cut it back to 15 to 18 inches, the ideal height varying with different individuals, all the way from 12 inches to 3 feet. Some owners even practice severe heading back for the first three years. Later they reduce the amount pruned, taking off from one-third to one-half. If the top has become too congested, entire limbs may be removed. Another method of eliminating small sizes is to pinch back the terminal bud of the annual growth about August 1, or as soon as the bud has set an adequate amount of fruit, so that the pinching will not induce the development of side branches. The pinching back naturally reduces the number of fruits set. It is contended that it makes those set grow to a larger size and ripen more uniformly.

Tillage. The fig is a very shallow-rooted tree, hence deep tillage is impossible. Some of the best growers advise that the orchard be not plowed at all. They contend that the best tillage tool is the ordinary hoe, and that the closer one approaches to this the better. Others favor mulching. Figs cannot compete successfully with weeds. They require a relatively large amount of moisture, and since they are very shallow-rooted the harmful affects of weeds or of deep tillage are frequently strikingly apparent. The cutting off of a root three-quarters of an inch in diameter may cause a tree to wilt.

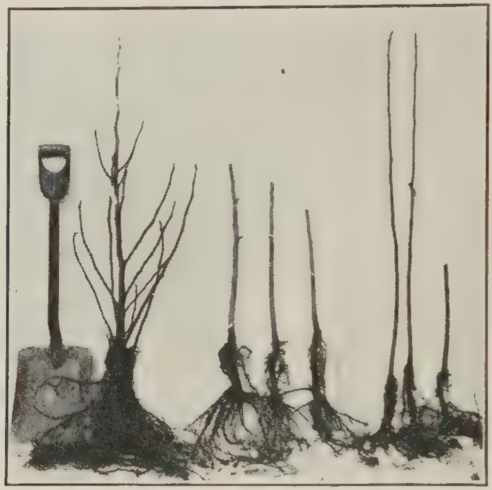

FIG. 157. Young Fig Trees ready for planting, one year old, from cuttings

From left to right—

1. A heavily branched tree of the Celeste variety
2. Magnolia trees cut back ready for planting
3. Brunswick, two trees not pruned, one cut back for planting.

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Cultivation. Cultivation should start in spring just before the plants begin to grow, and should be continued at intervals of a week or ten days until perhaps July 1, or a little longer for the later-ripening varieties. In some cases, a cover crop is plowed in during the winter. The time at which cultivation ceases varies with the ideas of the grower and with the location, but the common practice is to sow a cover crop some time during the summer. This may consist of cowpeas, beggarweed, or other crop, and is allowed to cover the ground until autumn. The cover crops appear to have a beneficial effect in shading the soil. The mulching of the trees with straw, pine needles or some other material is sometimes practiced in order to shade the ground and conserve the moisture. Such exceptional conditions are more frequently seen on light, sandy soils than on other types of soil. In some cases, the cover crop may rob the fruit crop of moisture. Cowpeas, with the exception of the variety Iron and one or two others, are quite subject to nematodes or eelworms, which are very destructive to figs. Where these are present the variety of cowpea sown should be carefully watched. It may be better to use the beggar weed or velvet bean, since they are not subject to nematodes. In Florida, where nematodes menace the roots, figs grown for home use may be mulched with stones or brick bats instead of cultivating.

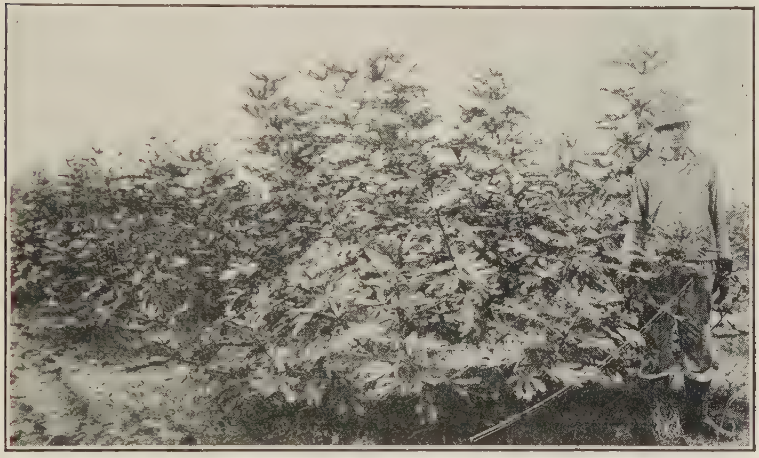

FIG. 158. Texas Wonder Fig Tree at Winnie, Texas, in midsummer of its fourth season

U. S. D. A.

Fertilizers. It is a common observation that fig trees are benefited by liming. They are frequently found growing very well on limestone soils and on those in which there are considerable amounts of oyster or other shells. It is generally observed that in the coastal regions in Texas where the figs do well that the soil contains much more lime than it does in certain regions of the Mississippi Valley further east, in which the figs generally fail. The fig cannot be grown on very poor soils, or soils deficient in humus. The use of stable manure and commercial fertilizer may be good economy on certain soils, but this must be determined. It is recognized that the soil should be well supplied with humus. In some cases bone meal is a useful fertilizer. The usual time of application is the spring at the time trees are resuming growth.

Fig diseases. The soft rot is a fungus disease and liable to attack the fig tree during hot, muggy, rainy weather. It makes its appearance as the fruits approach maturity. No effective control is given. Certain varietes are more subject to it than others. The variety Celeste, the one most generally planted, is one of the least susceptible. Keeping the tree well pruned so that sunlight may reach all parts of it and harvesting the fruit frequently and as soon as it can be gathered tend to reduce the trouble. **Rust** occurs wherever figs are grown, throughout the southern Atlantic and Gulf Coast states. The trees may be defoliated in August or early September, which causes the trees to put out another lot of leaves the same year. Some growers advise spraying with bordeaux mixture, using 4:5:50, making the application every ten to fifteen days, beginning before the trees start growth in the spring and continuing through the period of most active growth. Some growers contend that the dormant spraying is the most important of all.

Insects. The mature beetle of **the three-lined fig tree-borer** is a grayish-brown insect with three white stripes—hence the name. The eggs are laid from March to the fall. The eggs hatch and the borers work in the bark for two or three weeks and then penetrate into the wood where they live for two or three months or more, when they emerge to complete the cycle. The borers will not lay their eggs on sound, healthy trees, as they prefer those in which the bark is broken or the trunk split or where there are untreated wounds; they prefer wood which is dying. Prevention and control consist of smoothing off wounds and painting the cut surface with a mixture of five parts of coal tar and one part of creosote or crude carbolic acid. The mixture should not be put on the live bark, but merely on the wood. As soon as thoroughly dry, a second and perhaps third coat should be applied. Diseased and badly infested trees should be cut out and burned. The borers may be removed, as advised for other borers. (See Apple.)

Common Mealy Bugs sometimes cause a smutting of the leaves and small fruits, but usually they disappear in August. Generally, they are kept under control by parasites. The Soft Brown Scale is usually kept under control by natural agents. Wasps and bees will attack the fruit when cracked open. Birds sometimes eat the fruit. Of the pests perhaps the **Nematodes** are of the greatest economic importance. These are very small worms which live on roots, causing nodules. They cause great damage in the South and are most serious on very light, loose, sandy soils,—so much so that the continued planting of figs on such soils is not advised. The June bug is a serious pest in parts of the Western states.

Varieties. A fig tree may produce from one to three crops of fruit in a year, depending upon the variety and the conditions under which it is grown. In the Southern Atlantic and Gulf states, varieties such as Brown Turkey, produce a first and a second crop, but the second is the really important crop. A third is seldom produced. The four important commercial varieties for this territory are: Celeste, Brown Turkey, Brunswick and Magnolia. These four with perhaps six others, constitute the bulk of the planting, and none are of American origin. The varieties which require caprification have been successfully produced, but some feel that production is not probable owing to the climatic conditions. Time only will tell whether it is going to be possible to produce this class of figs successfully in the eastern portion of the United States. Smyrna figs are those used in drying, and require a climate favorable to drying.

Time of harvesting. Figs in the humid regions are quite perishable, and they must be promptly utilized as they ripen. This is especially true in damp, muggy, or rainy weather. Figs are quite apt to ferment and sour within a comparatively short time after being picked. They are apt to spoil on the trees from soft rot if left too long. They are not suitable for eating fresh until they are fully ripe and when in that condition the fruit is soft. For shipping, canning or preserving, the fruit should be picked before it begins to soften, but not until fully grown and at the point of beginning to soften. There is a market for the fresh fruit. It is usually harvested early in the morning, taking care to select only well-colored, firm fruits, which may be packed in strawberry baskets in carriers and shipped by express; but under such conditions, the distribution of the fruit is limited. A much larger quantity is taken by the canners for putting up as preserved figs.

Mode of harvesting. The fruit is commonly gathered in 10- or 12-quart pails. The pickers are usually furnished gloves or rubber finger-tips. Various means are taken to protect the hands and arms from the milky juice that exudes from the stems of the ripened figs when picked. This juice, if it comes in contact with the hands, produces irritation. The hands and arms may be smeared with oil or grease to protect them or washed in vinegar to counteract the effects. The fruit may be shipped in quart baskets, in the ordinary 24- or 32-quart crates, or in the Georgia peach crate; but this does not seem to be a suitable package since there is too much fruit in one container. There is not an adequate supply of fruit for refrigerator car shipment, so that distribution is quite expensive. For the canneries, the trees are gone over every other day. The fruit should not be over-ripe; otherwise the fig does not retain its form. The canners pay for the fruit by grade. The variety Magnolia furnishes figs which are usually skinned before canning, while Celeste figs are usually canned without removal of the skins.

THE FIG IN CALIFORNIA

California figs are of several types. Some of these so far, owing to climatic conditions, have not been grown successfully in the Eastern states. The Capri fig in California is not edible, but it is valuable because the little fig wasps (*Blastophaga grossorum*) breed in it. It is this wasp which is able to pollenize the flowers of a second group, the Smyrna fig; otherwise Smyrna figs would not bear fruit. In the Eastern states we frequently see Smyrna figs growing which set no fruit. This was the common condition in California until it was discovered that these little insects were necessary. It is the fertilization of the fig by these insects which is known as *caprification* because it is the insect from the Capri fig which does the work. In a third group, the Cordelia and allied varieties, we find staminate and pistillate flowers in each fig but located in separate parts, hence in such there is a dry inedible zone which was occupied by the staminate flowers, while below is the fleshy zone where the pistillate flowers were formed. A fourth group includes those varieties able to mature one crop without cross-pollination but not a second. The fifth group includes all the varieties of table figs which are capable of producing edible fruits without pollination. The figs used for drying are Smyrna figs. In California, three crops are usual; in fact this is common with almost all varieties in California, for there figs mature from July to frost.

Distribution. Figs are grown in California over the entire horticultural area wherever the temperature does not fall below 18 ° F. If given freedom, the trees will layer themselves, so that a single individual will become a grove. In some places the trees attain a height of 80 feet.

Fig growing as a whole is very well adapted to California. The soil is favorable, the climatic conditions are admirable and undoubtedly there will be a large increase in acreage and production, not only of Smyrna figs but also of others; and the industry may rank with that of the citrus fruits. At present California dry figs, owing to their thicker, tougher skins, are not as desirable as those from the Levant.

Climate. In California, figs do not thrive where there is much fog or where the summers are cold and windy. In such places protection is needed, such as offered by a wall or a building. Under such conditions, the trees will need much care during the first few years of growth. The trees increase in hardiness as they increase in maturity.

Propagation. Fig cuttings are usually set in the nursery in December or January and planted in the orchard a year later. Sometimes cleft-grafting is practiced, but it must be done with care; scions are placed on seedlings of Smyrna figs, or these may be budded by the ring method as used with the chestnut and walnut.

Distance to plant. The fig tree in California is frequently used for avenues. When planted in the orchard they may be set 40 or 50 feet apart, with other trees grown in between for a period of years. Trees chosen for growing table fruits are frequently headed about 18 inches from the ground. Those for drying are headed higher. The fruits are allowed to fall as they ripen. Land is kept in cultivation until the trees completely shade the ground. The trees usually begin to bear in the second or third year. Some trees are unproductive and must be removed. In some seasons the fruit is apt to be injured by fermentation, known as "fig-sour." It is sometimes claimed to be the result of over-irrigation. Similar conditions prevail in Arizona and New Mexico where the tree is generally selected as suitable for avenues, since it roots quite deeply where the soil is deep. In this way it is able to secure a sufficient amount of moisture so that no cultivation is required and little pruning is given. The conditions in California are markedly different from those in the Eastern states.

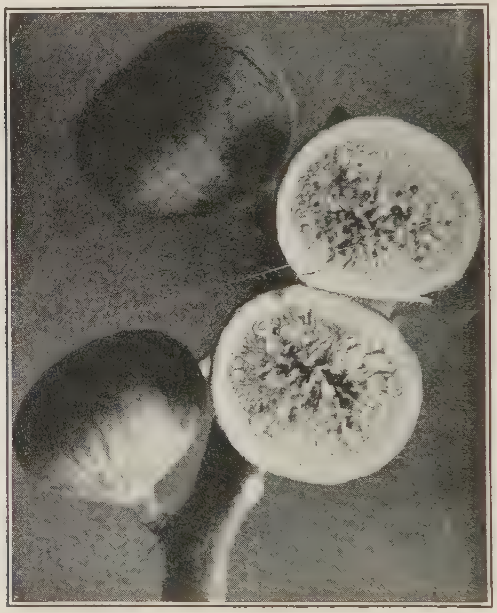

FIG. 159. Figs are borne in the axils of the leaves on new wood. The fruit is a fleshy cone with its flowers and seeds on the inside surface. The strawberry, on the contrary, bears its seeds on the outside surface of the fruit

Fruit of the fig. The fruit of a fig is a hollow stem, closed at one end with a small opening at the free end. It is known as a *syconus*. The flowers are borne on the inside surface of its fleshy walls. In the strawberry, we see the flowers and seeds borne on the outside of the fleshy wall, in the fig we see them inside.

Kinds of flowers. The fig carries four kinds of flowers:

1. Staminate flowers; sometimes spoken of as male flowers and rarely seen except in Capri figs; sometimes they are seen in Smyrna figs.

2. Pistillate flowers; sometimes spoken of as female flowers, commonly seen in all edible figs and sometimes in Capri figs. The Smyrna fig usually bears pistillate flowers only, and pollination is necessary to ensure growth of these figs. The pollen is carried from the Capri fig by the Fig Wasp.

3. Mule flowers which do not require pollenizing in order to attain an edible size. These are seen in the Adriatic or common figs.

4. Gall flowers, regarded as degenerate pistillate flowers, are not usually seen except on the Capri fig.

Kinds of fruits. Figs may be divided into two groups:

1. Those which bear pollen as the Capri and Cordelia, the Cordelia producing both staminate and pistillate flowers.

2. Those which do not produce pollen as (a) Smyrna, which produces pistillate flowers for all crops and need caprification. (b) San Pedro, which produces mule (first crop) and pistillate (second crop) flowers. This group requires pollen from the Capri fig to perfect the second crop. (c) Adriatic, which produces ''mule flowers,'' mainly in all crops and in which pollination is not necessary to secure edible fruits. These are the figs of the eastern United States.

Crops of figs in California fall into two classes:

(1) **Smyrna Figs.** The first crop of this class, the Brebas, is borne on wood a year old, the buds having lived through the winter. The second and third crops are borne on new wood.

(2) **Capri Figs.** In the Capri Fig, the crops are known as (a) the Mamme or first crop which passes the winter on the trees. The figs mature in early summer with the Brebas or first crop of edible figs. There is seldom anything but gall flowers in this crop, and in these the fig wasp winters. These figs may be gathered and stored in moss. They will keep for months, the wasps emerging from them in April. (b) The Profichi, which ripens before the second crop of edible fruit. They may appear in May and ripen in June or July. This crop carries only gall

and staminate flowers, no pistillate flowers, and the pollen is used to pollenize the second crop of Smyrna or San Pedro figs. (c) The Mammoni or third crop contains staminate, pistillate and gall flowers; these appear before the last of the Profichi have gone. Their main function is to furnish a home for the fig wasp until the Mamme form permits the establishment of the fig wasp in winter quarters.

Some Capri fig trees will bear but one crop a year; others two, and some three or continuous crops throughout the year. Their sole use is to furnish pollen and a home for the fig wasp, therefore, the latter or three-crop is the type desired. It will be recognized that the fig wasp must change its home three times a year, and three crops of figs are necessary to keep it alive. Capri Number One is regarded as an ideal variety.

Method of caprification. It requires skill to ensure caprification. The time at which the Smyrna figs are ready for pollination is determined by inspection. It is recognized by the external appearance, especially the color of the figs, for they assume a waxy appearance. When this occurs, the Capri figs are distributed among the Smyrna fig trees so that the wasps will be near the place where it is desired that they shall work. The mature figs are either hand-picked or are knocked from the Capri fig trees, with light bamboo poles. This is done early in the morning, at daylight and while the figs are cool, since the wasps emerge as soon as the fruit becomes warm. The emergence may continue daily for days. The capri figs are gathered in cone-shaped baskets about 3 inches wide at the opening, perhaps 10 inches long. Six to ten figs of average size are required for trees four to six years old; twenty to one hundred for trees ten to forty years old. For small trees, one basket is used; for large trees, two or three baskets are hung in different locations in the top of the tree. Fresh Capri figs are gathered every week or ten days and for as long a time as is necessary to ensure pollination.

In planting Smyrna figs or San Pedro figs it is necessary to plant one Capri tree for every 100 Smyrnas. If this Capri tree is thoroughly laden with the wasps there will be an adequate number to pollenize properly the Smyrna figs. Some orchardists claim that two or even four trees per acre is a wise precaution. The wasps live in the small figs produced on the Capri fig tree. The males have no wings. The females have.

The work usually begins in June and if the Capri figs are examined at this time, it will be found that in the Profichi crop the staminate flowers are situated at the lower end of the cavity, while the gall flowers, in which the young wasps hatch, are at the upper end of the cavity, so that in trying to escape through the opening, they become thoroughly coated with pollen. The female wasp seeks to enter another fig for the purpose of laying her eggs in the gall flowers which are present in the Capri fig, but she cannot differentiate between Smyrna and Capri figs. Accordingly, when the ripe Capri figs are hung in the Smyrna trees, the wasps, laden with pollen, push their way into the Smyrna fig, losing their wings in the process. Hunting around in the flowers for a place to lay her eggs, the wasp thoroughly pollenizes the pistillate flowers, thus ensuring a crop of figs. At least one wasp is required for each fig.

Any eggs that the wasp may lay are absorbed with her body. Not until these small Blastophaga were imported into this country were we able to grow Smyrna figs. We grew Capri figs long before we brought the insects and naturally we did not get any results; but now the whole problem is understood. There are probably more problems undetermined in regard to the figs which are of non-Smyrna types than there are in regard to the Smyrna figs in California.

Fig drying. Figs are picked up as they fall. As they mature, they shrivel. The usual course of procedure is to dip them in boiling brine. They are then placed on trays in the sun, turned over once, and then allowed to finish in the shade. They are then placed in sweat boxes so that the moisture will equalize; are again washed clean in a weak brine and packed. Some of the dry Smyrnas of California contain 64 per cent of sugar.

Figs for shipment fresh. Carlot shipments of fresh figs are now made to eastern markets. The fruits are packed singly in pockets made from corrugated cardboard dividers, the fold or corrugation being large enough to hold a fig. Some boxes hold but a single layer. The fruit sometimes arrives in poor condition, showing mold, but with experience it is anticipated that the various problems will be solved. An organization comprising the peach and fig growers is actively at work in California attending to the problems of distribution and marketing as well as the production of figs, and it is anticipated that this fruit will be one of rapidly increasing importance.

CHAPTER LXV

THE GUAVA AND JABOTICABA

Guava (*Psidium guajava*). The guava jelly which is becoming fairly well known, is made from the fruit borne on a tree of the Myrtle family, a native of tropical America. It is now distributed throughout sub-tropical America, and is fairly common in Southern Florida, where some forms of this plant have escaped from cultivation and have constituted themselves a weed. The plant is known in Southern California as the lemon guava. The common guava of the tropics is *Psidium guajava,* of which there are a great many varieties. The tree may attain a height of 25 to 30 feet. The fruits vary from spherical to pear shape; and in size from 1 to 4 inches in diameter, although the most common varieties are about 2 inches in diameter. They have light yellow skins which enclose the finely granular pulp, beneath which is found a mass of softer

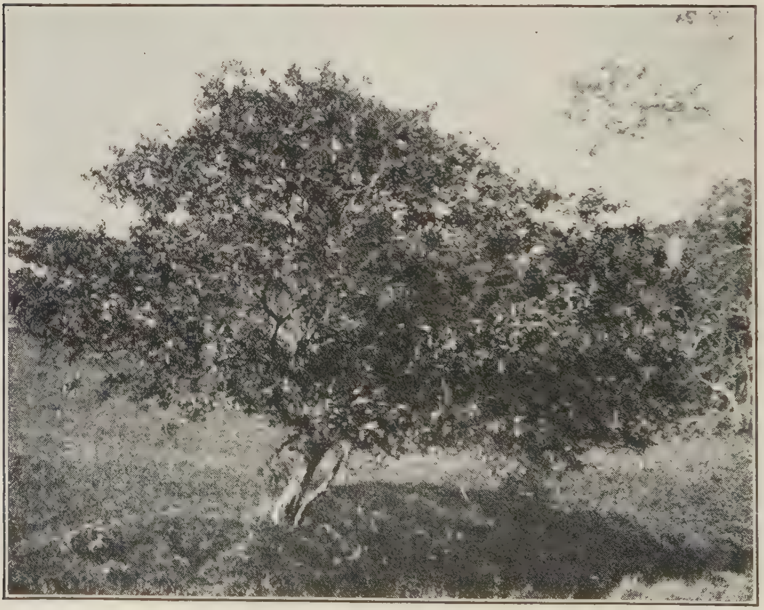

FIG. 160. The Guava (*Psidium guajava*) tree, Costa Rica

Bronx Park Bot. Garden, N. Y.

pulp in which the small seeds are found. The flesh varies in color from pink to salmon. When ripe, it is sweet or somewhat acid and nearly always somewhat musky. The fruit may be eaten out of hand; sliced with cream; used in short cakes, pies and in preserves, or be stewed; and is highly valued for the manufacture of jams and jellies. The jelly from it retains the peculiar musky flavor.

The Strawberry Guava or Cattley (*Psidium cattleianum*) is the species most frequently found in California because of its ability to endure low temperatures. The plant has withstood a temperature as low as 20° F. without injury. The tree is not as large as the common guava of the tropics, usually not attaining a height of more than 15 to 20 feet, nor is the fruit as large. It is usually pear-shaped, sometimes spherical, and but 1 to 1½ inches in diameter. It is usually borne in abundance. The skin is purplish maroon and encloses yellowish-white flesh. The seeds are usually numerous. The flavor is believed by some to resemble that of the strawberry, hence the name. In California, the fruit is largely used for making jelly, but it has not the same flavor as that of the common guava of the tropics. The variety, *Psidium cattleianum lucidum*, or sometimes listed as *Psidium lucidum*, is grown both in Florida and California, and differs from the ordinary strawberry guava in that the color of the skin is usually sulphur yellow, and the flavor, if anything, is milder than that of the red Guava.

Pineapple Guava is the Feijoa. There are a number of other members of this group in Brazil and other portions of tropical America, all capable of improvement by selection and budding. So far most of them have been propagated by means of seeds. The Pará Guava (*Britoa acida*) is not properly a guava, although it has been distributed under the name of *Psidium araçá*. It is worthy of dissemination.

Soils and climate. The guava can be grown in any soil, except perhaps in a bog. If the soil is too rich, the growth is apt to be rank and the flavor poor. They are found growing along the Gulf Coast, and in Texas and Florida. Some have suggested that they be grown in sheds, as is the pineapple in Florida, in order to furnish a certain amount of winter protection. Mature plants of the guava may be injured by temperatures of 28 or 29° F., while the strawberry guava may be expected to withstand 22° F. Young plants of the common guava may be killed by temperatures one or two degrees below freezing. Both species prefer a rather dry climate. The plants may be carried through a mild winter by bending them down and covering with a straw mulch. Frost may destroy the tips, but the plant will renew itself from the roots. The strictly tropical varieties are the most sought, because considered best.

Propagation. Since the seeds hybridize quite easily, seedlings are quite variable. Propagation is accomplished by layering or grafting in the usual way, and sometimes by rooting cuttings, which is difficult, although if mature wood cuttings are given bottom heat in a frame satisfactory results may follow. Seedlings and rooted cuttings may be potted off when small and grown in pots until ready to plant out, since they do not transplant very well. In California, budding has been successfully accomplished with large stocks 1 inch or more in diameter. Square or oblong patch buds about 1½ inch in length are used, but the method is not capable of commercial practice. The attempt has been made to develop some form of shield budding as practiced for citrus fruits. Seeds are usually planted as soon as possible, in a light, sandy loam soil. Transplanting of the trees is done in late spring.

Planting. In California the strawberry guava is often planted 10x10 feet on rich soils and in the tropics a greater distance is better. The common guava is given space up to 15 feet apart, and in India 18 to 24 feet apart. The trees are mulched after planting with weeds or straw and in some cases cultivation is practiced and the plants are manured. If necessary, irrigation is given every ten days. Little pruning is done. Planting is usually done in April and May in California, and in October and March in Florida. Seedlings may come into bearing in three or four years after planting, budded plants in two years and may live up to forty years. In India, it is claimed that the tree bears heavily for fifteen to twenty-five years and then production declines.

Time of ripening. The fruits ripen throughout the year, the heavier production being from August to October. The trees are very productive, have no off years, and appear to carry fruit at all times. Some have called it the "Apple of the Tropics."

Insects and diseases. In California, the Psidium Guava suffers from the black scale (*Saissetia olœa*), which is usually controlled by fumigation or spraying. In other parts of the country, it seems to be free from this or other troubles. This is also true of the Cattley Guava. In some cases, however, the fruit is injured by the Mediterranean Fruit-fly. Guava Rot is a common disease in some places. It is caused by a fungus (*Glomerella*). The strawberry guava is less subject to attacks of insect pests than the tropical guava.

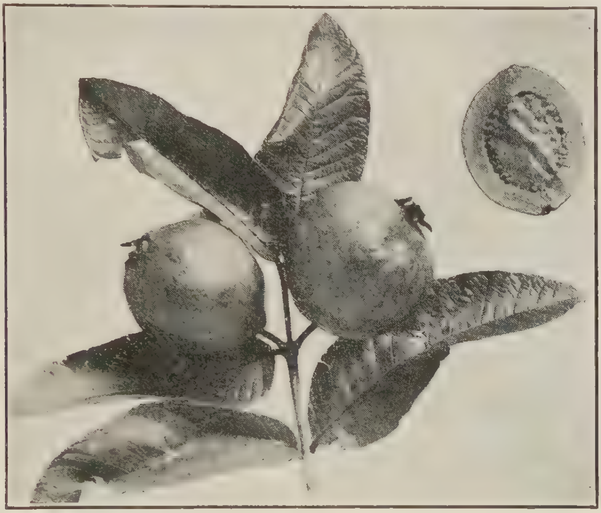

FIG. 161. Guava (*Psidium guajava*). Fruiting branch
Photo by E. L. Crandall, U. S. D. A.

THE JABOTICABA

Several forms of trees are known under the name of Jaboticaba (*Myrciaria spp.*). The trees are found growing at their best in Brazil. The Jaboticaba (*Myrciaria cauliflora*) has been introduced into California and Florida, but in California it so far has made very slow growth. It appears to be adapted only to the most protected locations. There may be parts of Florida to which it is adapted. The young trees are easily injured by frost; as they acquire age they can stand a slight amount of frost. The tree prefers a deep, rich soil. It is tardy in coming into bearing, usually in six or eight years.

Climate. At Miami, Florida, the tree has survived a temperature of 26° F. It appears to demand a moist, equable, cool climate, with temperatures never below freezing.

Propagation. The usual method of propagation is by seeds, although good varieties are propagated by in-arching or other means. The fruits are borne all over the trunk and branches of the tree. They grow from one-half to one and one-half inches in diameter, are purple in color. The skin is somewhat like that of a grape, but tougher. The flavor suggests the grape. The fruit is consumed fresh or is made into jelly or jam.

CHAPTER LXVI

THE JUJUBE AND LITCHI

The Jujube. The Chinese (*Ziziphus jujuba*) and the Indian (*Zizyphus mauritiana*) are species of a slow-growing, medium-sized thorny tree, native of New Zealand, Asia and Africa. It may reach a height of 50 feet. The plants have handsome foliage and are grown in shrubberies throughout the Southern states and in California. For commercial use, the plant is promising in Florida, California and the Southwestern states, where it seems to thrive on any well-drained soil. Seedling trees have grown as far north as Maryland, but they fruit sparingly. In Georgia they fruit well. This plant has been cultivated in China for thousands of years. It is grown in northern Africa and is relatively hardy, having endured a temperature of 13° F. at Chico, California, and 111° F. in the summer. No weather appears to be too hot for it. It enjoys brilliant sunshine, long, hot summers, dry weather, and under such conditions it bears early, regularly and abundantly.

The fruit may be 1 to 2 inches long. In California it ripens in October and November. In the best varieties, it attains the size of a large prune and is reddish or mahogany in color when ripe. It may be eaten fresh; it is more often processed with sugar or honey or used in making syrups, lozenges and confections. Prepared jujubes are as delicate in flavor as many of the dates.

Propagation and seedlings. The plant is propagated by seeds, green wood cuttings, sprouts, root cuttings, budding and grafting. Since the seeds are quite hard, it is advisable to crack them. This hastens germination. If not cracked, two years may be required for germination. The trees come into bearing quickly, sometimes when one year old, but generally they take four years. Year-old seedlings may be grafted but many prefer to let them grow two years. Mature, grayish budwood should be used in budding, from which the leaves have fallen. Large buds should be cut from 1¼ to 1¾ inches long. The age of the stock at the point of inseration is not of importance. The use of sprouts is probably the easiest way to propagate, since sprouts are formed in great abundance.

Grafting. Bench grafts may be made as outlined under Apple, either by whip grafting when the stock is small, or by cleft grafting if the stock is large. Grafts made in February or March may be held in redwood sawdust or shingletow at a temperature of 40 to 50° F. to callus and will be ready to plant in April. In California, they are planted about April 1.

Varieties. The Chinese have over 400 varieties which have been developed for special purposes as for eating fresh, drying,

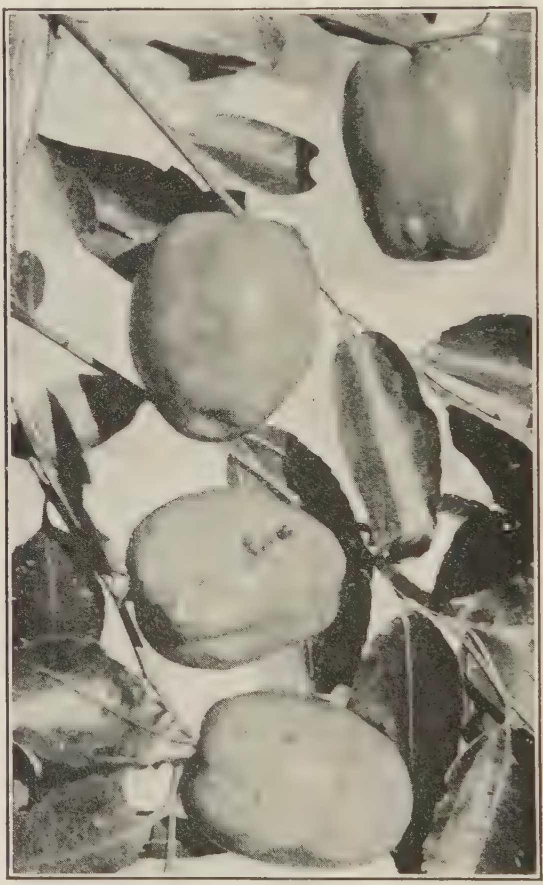

Fig. 162. "Ta yuan tsao" or the large round jujube is one of the large-fruited varieties of *Zizyphus jujuba*. It is propagated by suckers and is promising

Photo by Frank M. Meyer, China, U. S. D. A.

(Reduced one-third)

etc. Some are seedless. They vary markedly in flavor. The common Jujube (*Z. sativa*) is quite hardy, and is grown in Florida and California and further north. The fruit ripens in November and December. The trees come into bearing three years after planting. The fruits are the size of a large olive.

Planting. The trees are usually planted 15 to 20 feet apart. Trees planted in Sonoma Valley in 1876 were 25 feet tall and bore abundant, annual crops forty years later. This tree will grow on all kinds of soils except heavy clay. It will not thrive in wet locations.

Cultivation. A similar style of culture as described for citrus fruits is best except that usually the plants do not need much irrigation. The trees come into bloom in June, so there is no danger from frost. They are regular in bearing and are productive. In China they rarely live over forty years and decline in vigor after twenty-five to thirty years of age.

Harvesting. For eating fresh or for preserving or making glacé fruit the fruit is gathered as soon as ripe and has a mahogany color. For drying, it may be allowed to hang until it turns darker and dries somewhat, which is attended by a wrinkling of the skin. Such fruit, if further dried in the sun, may be kept for a year or more.

THE LITCHI

The Litchi (*Litchi chinensis*) is regarded by some of the Chinese as the most luscious of fruits and in Asia millions of people are familiar with it. It is a small to medium-sized tree, cultivated in South China, India, parts of Australia, West Indies, Brazil and is promising, commercially, in Florida. It has fruited in parts of California, but it is doubtful whether it will become a commercial success in that state. The fruits are borne in clusters and resemble strawberries, are deep rose color when fully ripe, changing to dull brown as the fruit dries. The outer coat is hard and brittle and the surface rough. It contains a seed which varies in size from small to large. The flavor is sub-acid, something like a Napoleon cherry. The flesh is whitish, juicy and somewhat firm in texture. The fruit is usually seen in American stores in a dried state, although canned fresh fruit is now on the market.

Soil and climate. In China it succeeds best on deep, black, rich, somewhat acid soil where there is an abundance of water.

In Florida it is doing well on a light, sandy loam, but not on dry, rocky soils in southeastern Florida. The litchi is tropical in all its requirements, some varieties are as hardy as the lemon. It prefers a moist climate, abundant rainfall and freedom from frost. Heavy winds are injurious, especially while the tree is in bloom.

The requirements for successful culture are: (1) Freedom from injurious frosts. (2) A humid atmosphere. (3) A deep loam soil. (4) An abundant supply of soil moisture.

At Miami, Florida, plants 6 feet tall were killed by a temperature of 26° F. The mature plant will not be so seriously hurt

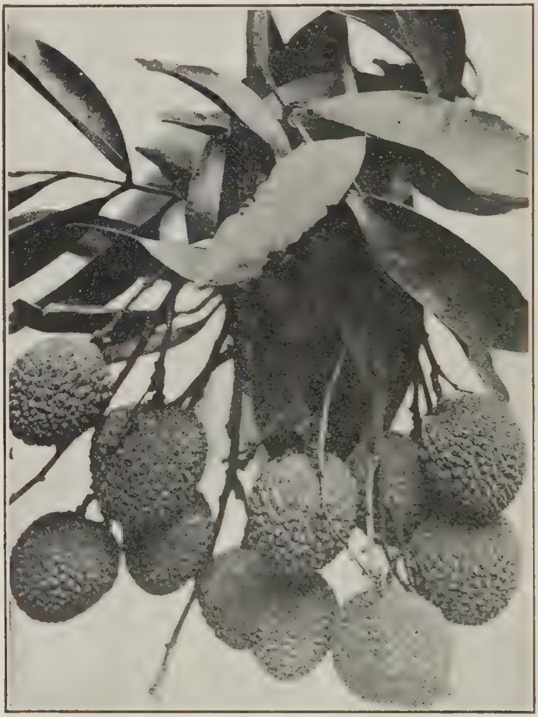

FIG. 163. The Chinese Litchi about one-third size. In southern China it is as important a fruit as the peach is in America. It grows on wet land, is productive and the fruit is used fresh, preserved and dried. There are many varieties adapted to subtropical regions. For the tropics the nearly related Rambutan and Palusan are worthy of a place

Photo by E. L. Crandall, U. S. D. A.

by such a temperature. The trees need winter protection until five or six years old in several localities where the trees will grow. While preferring a humid climate, it is doing well in the relatively dry climate of Santa Barbara, California, but it needs more irrigation than other fruit trees. It is growing in Hawaii.

Propagation is effected by layering, grafting or in-arching. Seedlings may be used as stocks. The seed should be sown as soon as possible since its vitality is impaired if dried out. The Longan is sometimes used as a stock. The branch which is to be layered is notched on the under side and is then covered with soil for a distance of several inches. This branch is kept moist until it takes root. If the branch is not bent down to the ground the soil is put in a flat or suspended box, and is kept properly moist. Another method is the Gootee. A narrow ring of bark is removed just below a node or bud on a healthy twig and the cut surface is then covered with clay soil which in turn is covered with moss or other substance that will keep it moist. Water is allowed to trickle very slowly from an earthen vessel suspended above until the ball of clay soil is filled with roots. Three or four months may be required. When it is well rooted, it is removed and planted.

Varieties. There are several varieties in cultivation in India and China. McLean and Bedana are well known in India and Loh Mai Chi is said to be one of the best.

Management. In Florida, trees are often planted about 25 feet apart but 40 feet is better for a desirable location. Little pruning is given. Thinning the fruit to reduce the number in the cluster tends to increase the size. Applications of manure from time to time are regarded with favor. When mature, the trees will withstand several degrees of frost without permanent injury. Reasoner in Florida has grown it under a muslin shed, which is removed in the summer. It is claimed that the tree is shallow-rooted and mulching is much better than cultivating the soil.

Insects and diseases. Borers and scale insects attack the trees, fruit worms attack the fruit, and such will undoubtedly be found in this country if the culture of this plant be carried on.

Bearing age. Seedling trees have been known to bear at five to seven years of age, more often seven to nine. Layered plants bear earlier; sometimes they produce a few fruits when two years old, but three to five is more common. The tree is long-lived, and should continue in profitable bearing for a hundred years. With care, they produce annual crops of 200 to 300 pounds of fruit. Crops of 1,000 pounds per tree have been reported.

Harvesting. The custom is to break off the twig which bears the cluster of fruit. If individual fruits are gathered they lose their keeping power. The fruit may be held two or three weeks without loss of flavor, but soon loses the red color. The fruits can be shipped under refrigeration. In southern China the fruits ripen from May to July.

RELATIVES OF THE LITCHI

The Longan (*Euphoria longana*) resembles the Litchi. As grown in Florida and California, the fruits are not considered as good as Litchis but when preserved they are said to be superior to preserved litchis. The plant will thrive in California and Florida where the litchi cannot. It is less exacting in its requirements. It is more successful on the shallow soils of Florida than is the litchi.

The Rambutan (*Nephelium lappaceum*) is a strictly tropical plant, likes a moist, hot climate and will probably not succeed except in extreme southern Florida. In its habits it resembles the litchi. There are several cultivated varieties.

The Akee (*Blighia sapida*) is a native of tropical West Africa. It is grown for its capsule-like fruit which contains three seeds with a whitish fleshy body at the base of each. This portion is sometimes cooked. Trees are growing at Miami and Palm Beach where they have passed through a temperature of 26° F. with little injury. No large plants are reported from California. Propagation is usually from seed.

The Mamoncillo (*Melicocca bijuga*). The tree is slow-growing and may reach 60 feet in height in the West Indies. The fruits are small, round, and look like plums. They have a thick, leathery surface which encases a soft, yellowish, juicy pulp and seed. The juice may be sweet to acid, being known as the honeyberry and as the Spanish lime. The fruit markets well in parts of Florida. Mature trees are growing at Miami and Palm Beach, but it is not reported to have fruited in California. It is not exacting in its requirements.

CHAPTER LXVII

THE KAKI

The Kaki, known as the Japanese and Chinese Persimmon (*Diospyros kaki*) is a native of China where it has been in cultivation a long time. It is the national fruit of Japan. The plant is cultivated in the United States from the Mason and Dixon line, south, although it has fruited as far north as New Jersey. Few varieties can withstand zero temperatures. There are some hardy varieties in Japan which would probably ripen fruit in New England. The principal orchards are in Florida, the Gulf States and California, and these appear to have ideal conditions for the growth of this fruit. By crossing these Japanese varieties with the American persimmon, varieties as hardy as the American species may be secured, which will have a similar distribution. The tree may attain to a height of 40 feet though there are dwarf varieties which grow 5 to 6 feet high and up to 20 feet. The leaves are from 3 to 7 inches long and variable in shape. The fruit varies in shape and is from 1 to 3 inches in diameter. It has a thin orange-yellow to a reddish skin, orange-colored pulp and it may have eight seeds or less, in some cases none.

The flowers are all borne on the current season's growth and open shortly after the shoots and leaves are developed. Some trees bear male flowers (staminate); others bear female flowers (pistillate); another year they may bear perfect flowers. Again, a single tree may bear all three kinds of flowers. Staminate flowers appear in three-flower clusters in the leaf axils. These furnish pollen only. They set no fruit. They are needed to furnish the pollen. Pistillate flowers or female flowers appear singly in the axils. These have a light yellow corolla, eight stamens which bear no pollen, and an eight-celled ovary surmounted with a style having four parts. Under certain conditions, some of the staminate flowers may develop into perfect flowers, but this is rare. It is advisable to include a good pollen-bearing variety like Gailey in each block.

We may note that in the Papaya we have trees which bear staminate flowers and some which bear pistillate flowers; also that sometimes those which bear staminate flowers may change and produce perfect flowers.

Seeds and correlations. There is a correlation in shape of the fruit and shape of the seed. Round fruits have short, broad and flat seeds; oblong and conical fruits have long, narrow-pointed seeds. The number of seeds varies from none to eight. Some varieties as Tanenashi and Hachiya while classed as seedless, occasionally contain a seed. The light flesh varieties are all very astringent until dead ripe and some seem never to lose their "pucker," but the pucker may be removed.

Varieties. The fruits vary in shape—oval, oblong, conical and otherwise. The round fruits are early and the oblong late-keeping. The latter kinds may be stored for two months or more. The fruits vary in weight from a few ounces to over a pound. In color, the skin when ripe ranges from light yellow to dark red. In color of flesh there are three groups. The light flesh, as: Hachiya, Triumph, Tanenashi, Tsuru, are all seedless. In the dark flesh group are Hyakume, Mio-tan, Yedoichi, Zenji. Among mixed-flesh varieties may be mentioned Okame, Taber 23, Taber 129 and Yemon as important. In these the flesh is not blended but appears distinct, and seeds occur in the dark-fleshed area. The dark flesh varieties are never astringent and may be eaten while still hard, much as we eat an apple. Zenji is best eaten while still hard; others are better if they have been allowed to soften a little. Varieties for home

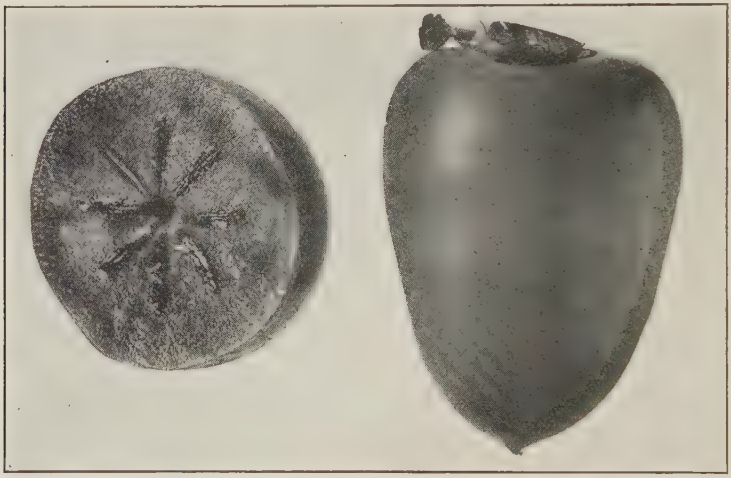

FIG. 164. Tsuru variety of Kaki or Japanese Persimmon
Calif. Agr. Exp. Sta.

use to furnish a succession might include: Yemon, Hyakume, Zenji, Hachiya, Triumph, Tsuru. For commercial use: Yemon, Taber 129, Hachiya, Hyakume, Triumph, Tsuru and Zenji. Fuyu is an excellent, productive non-astringent variety which may be eaten while hard without processing.

Climate and soil. The Kaki is a sub-tropical fruit. It will grow where the fig thrives. It will endure semi-arid conditions in California and it is growing in regions of heavy rainfall. The best soil is one deep, somewhat heavy, having good drainage and a fair amount of humus. In Japan, the soil best adapted is a gravelly clay loam, neither too dry nor too damp. For orchard planting, the land should be put in good condition by growing a crop of beggarweed, velvet beans or cowpeas and turning this under. In California the tree is often planted along the irrigation ditches and it may be planted along streams in the South.

Propagation. The tree may be propagated on native seedlings or Japanese stock. (*D. lotus*). The native seedlings are preferable, being more vigorous and giving a large tree. The Japanese stock seems to be better adapted to the drier parts of the West. In Japan, trees on this stock have a long life. The seeds should be secured from the healthiest and most vigorous American trees. These should be handled like peach pits—be sown in a nursery bed; from which, on attaining a height of 10 to 12 inches they may be transplanted the following spring to the nursery row. None but the best seedlings should be used. They may be budded or collar-grafted in the nursery row and as soon as the graft has made a satisfactory growth the tree may be moved to the orchard. Sometimes the graft will grow 5 to 6 feet the first year. The roots of the persimmon are poor, consisting usually of a long tap root. The transplanting outlined will aid in developing a good root system.

The scion should not only be of the variety desired but be from the best tree of the variety. In its selection one should consider not only its vigor, productivity and healthfulness, but the character of the fruit itself. The scions should be taken from the best parts of the tree where the branches are well exposed to the sun and those which bear the best types of fruit. They should not exceed one-half inch in thickness. Grafts are usually cut 4 to 6 inches long. Usually the scions are cut just before use, or they may be cut in fall and stored in sphagnum moss until needed. Seedling trees, during the first two or three years, bear only male flowers; later a few female flowers begin to appear on some trees, but half of them will produce male blossoms only, for life. The fruit borne by seedlings is frequently of little value.

Grafting is the usual mode of propagation. Crown grafting below the ground level is better than root grafting. Either a cleft or a whip graft may be used. The cleft graft is usually employed on large stocks or for topworking older trees. The whip graft is preferred for all stocks less than one-half inch in diameter. Grafting tape or waxed cloth is used to bind the scion and stock together. Grafting is done while the stock and scion are dormant. Budding may be done during the summer and in favorable seasons a fair stand of buds may be secured.

Planting. The best time to plant in Florida is during December and January; elsewhere as early in the season as is possible, in order that the tree may become established before the growing season begins. The roots need ample protection from sun and wind during transplanting and the tree should be well watered after setting. The usual distance is 15 to 20 feet apart, in California 24 feet. Some varieties as Triumph and Hachiya are spreading in habit of growth and need more space. Others as Costata are upright. At the time of planting it is customary to cut back the young trees to within 2 to 2½ feet of the ground; some prefer 18 inches. The tap root should be cut back to 18 inches.

Orchard management. The orchard may be handled as outlined for oranges. On dry soils cultivation during spring and summer and a cover crop sown later is suggested. On moister soils, where there is adequate rainfall, a crop of beggarweed or other crop may be grown between the trees. This may be mown at intervals to furnish mulch, practically no cultivation being given. The tree grows normally in old fields without cultivation. In Florida the trees respond to an application of fertilizer, a 3:6:10 mixture applied at the rate of 5 pounds to a tree six years old. Growing leguminous cover crops may furnish all the nitrogen required.

Shaping the tree. The shaping of the tree will depend upon the variety. Those which make thick, bushy tops may need some thinning, while those which tend to grow upright will need some control to secure a desired shape. The trees are precocious, sometimes bearing several hundred fruits at three years of age. They need thinning in early summer, otherwise they are short-lived. The trees are trained to a goblet shape as outlined for the peach. Four limbs are left to the head. These are cut back at least half the first year, and they are pruned for the next two or three years. After that time the growth made is restricted by the heavy crops, and little pruning is given, but thinning may have to be resorted to.

Insects. The insect enemies include the San José scale, which does not often attack the tree seriously, but does considerable damage to the native persimmon. The White Peach scale sometimes attacks the tree in Florida, but is controlled by a dormant spraying with lime sulphur as for San José scale. The Twig Girdler works on the twigs of the tree, causing them to die. The twigs fall to the ground with the larvæ in them which pupate in the ground and emerge to repeat the cycle. Cutting off and burning the twigs as soon as seen will get rid of the insects. The flat-headed borer (*Dicera obscura*) is a serious enemy. It must be hunted like other borers, destroyed and the wounds painted with white-lead or some other wound cover.

Harvesting. The fruit is gathered before it is fully ripe, and before it softens if it is to be shipped to any distance. It is cut from the tree with orange clippers and must be handled with care. Fruits are taken by hand from one receptable to another and not poured. Damaged or bruised fruit is of no value for shipment. For home market the fruit may be ripened in a warm, dry room. The fruit so ripened has as good flavor as that ripened on the tree and if left on the tree is apt to be injured by birds. In Florida fruit may be harvested from August to December or later; in California from September to December. Roeding gives the ripening season in California as—Tanenashi in September, Hachiya in October, Hyakume in November, Yemon in December. In Florida Zenji ripens in August and continues for sixty days, the seedless ones being large and later; Okame and Hachiya begin in early September and last a month; Hyakume from September 15 to 30; Tanenashi and Yemon follow; Triumph begins to ripen in September and lasts to December with the main crop in October; Yedoichi begins in early October; Costata later in the month; Tsuru last of all.

Packing. Florida fruit is wrapped and packed in the Georgia peach carrier. Two sizes are packed, the smallest not being shipped. The pack will depend on the size of the fruits. Some California fruit is shipped in box carriers, holding trays in which the fruits are placed in single layers. There is a growing demand for some of the large and finer fruits. In California, fruits were wholesaled at 6 to 8 cents a pound in pre-war times. The Eastern markets appreciate the fruit more highly than do those of the Middle West.

Uses. When properly ripe the fruit is excellent to eat raw. The flesh is jelly-like and is eaten with a spoon. Some add cream to it. It may be cooked and made into puddings and marmalades. The fruit is rich in sugar, often containing over 17 per cent, or nearly as much as the French prune and the White Adriatic Fig, and but little less than the average California grape. Such varieties as Hachiya are dried like Smyrna figs.

Processing Persimmons. The Japanese remove the pucker from persimmons by placing them in casks that have been formerly used for holding Sake, which is their beer. The Sake that has been in the casks should be of very pure quality and not adulterated with alcohol. The casks are usually made of cypress wood, which is quite soft and tasteless. The head of the cask is removed and the fruit placed in it; then it is reheaded and in from five to fifteen days, according to the weather and the variety of the fruit, the persimmons are removed and are in firm, sound condition, ready for shipment, with their astringency gone and their flavor fine. The duration of the period in which they should be left in the casks is a matter of judgment, the men doing the work becoming experts.

Research since 1905 shows that the astringency of the persimmon is due to the presence of tannin, localized in certain cells in the pulp. These cells are quite large and are also seen in the date, which is quite astringent while green, but this disappears during ripening. The reason we do not taste this tannin immediately we bite the persimmon is that the giant cells do not break immediately, but absorb water from the saliva in the mouth, swell slowly, then burst, emptying their contents of thick, liquid, tannin-bearing substance on the tongue, so that we never get the full force of the tannin of a half-ripe persimmon until it has been in the mouth at least a fraction of minute. As the fruit ripens, these cells become so hard that water has little effect on them. It was found that in the presence of the fumes of carbon dioxide (provided a certain amount of dry starch was present to prevent cracking of the fruit) that the same results were accomplished.

The fruit may be ''processed'' quite readily after it has been in cold storage. Persimmons held in cold storage for twenty-seven days when ''processed,'' softened rapidly. This softening might be delayed if the fruits were promptly precooled, since the fruits do not soften so rapidly at low temperatures, and undoubtedly, processing may be more successfully employed when the fruit is approximately at destination. The variety Hachiya, when fully colored but still firm, may be rendered non-astringent in much shorter time than when the fruit is more mature.

In Florida the number of days required for keeping fruits in carbon dioxide in order to make them non-astringent was as follows: Triumph, 1⅔ to 2½; Imperial, 4½; Hachiya, 7; Okame, 4½; Tanenashi, 7; Zenji, 2; Costata, 4; Hyakume, 1½, and Yemon, 1½. In Washington, D. C., owing to the lower temperature, processing took a longer time. Higher temperatures hasten the process. The fruit is placed in a tank, often in the basket in which it is shipped. The carbon dioxide, which may be obtained in cylinders, is emptied into the tank, where it displaces the air. Fruit must be watched to see that it is not over-processed. With one exception—yellow fleshed Zenji—processing greatly injured the shipping qualities of the fruit. Tanenashi was less seriously affected than many of the others.

Dried persimmons. In drying, persimmons are first peeled; in this work nickel-plated knives are used because iron knives stain the fruit. The fruit is dried at temperatures not exceeding 122° F. The variety Tanenashi seems to be best suited for this work. The dry slices are stored in containers so that the moisture may equalize in them before they are packed. They are then sometimes pressed into small bricks in which form they are distributed. They are regarded as a very attractive commodity, and it is felt that when the problems of drying are solved, the future for the commercial production of persimmons will be much brighter.

Selling fruit. The public need instruction in the use of this fruit in the fresh state. They should be encouraged to purchase it while firm, take it home and if they have a cellar, hold it there until soft. Its value will then be appreciated

CHAPTER LXVIII

THE LOQUAT AND ITS RELATIVES

The Loquat (*Eriobotrya japonica*) is a relative of the apple, pear, quince, etc. The tree is a small evergreen which has been in cultivation for a long time in Asia and is a native of China. It is an important fruit in Japan where it has been long grown. The tree may attain a height of 25 feet. It bears small, white, fragrant flowers which are produced in fall. The crop is grown commercially in California and Florida and southward to Chile and Argentina. It does particularly well in Southern California, and is grown in gardens over a wide area. Usually it can be grown wherever lemons are successfully produced and perhaps north of such an area. It is grown in Southern France, Italy and Algiers and when given the protection of a wall is found growing in London. It grows well in Northern Australia and Queensland. The developing fruit is liable to be hurt by temperatures much below 30° F. Ikeda, a Japanese authority, believes that the fruit reaches its highest degree of perfection when grown near the sea coast.

The fruit. The fruit ripens in the spring. It varies in color from pale yellow to deep orange. It is sometimes 3 inches long, spherical to pear-shaped in form. The skin is thin, smooth, somewhat tougher than that of an apple. The flesh is usually white to salmon color, juicy, of a flavor suggesting a cherry, firm and meaty in some cases and almost melting in others. The seeds are found in the center of the fruit; they are about three-quarters of an inch long and vary from one to nine, four or five being common. The fruit is eaten fresh or it may be preserved in the form of jellies, jams, or used in making pies. In California, fruits ripen and are marketed from late February to June. The Florida crop matures somewhat earlier. The same variety may not mature as early in one district as it will in another.

Varieties. Many varieties in use in Japan have been introduced into America. The varieties which mature their fruit early in the season are the most sought. The fruits should be large, of good quality; a rich orange-red is generally preferred in color, although some lemon-yellow are considered satisfactory. The seeds should be small, the flesh thick; the aroma should be cultivated; some varieties possess little, others are decidedly aromatic; the fruit must have firm flesh and a rather tough skin, be a good shipper and resistant to disease, especially pear-blight. The Japanese classify them into two groups: the Chinese and the Japanese. The Chinese group have large fruits, pear-shaped, of deep orange color and firm, meaty, orange or yellow flesh. These varieties are late in ripening. Among them may be mentioned Thales and Tanaka (Gold Nugget). Varieties of the Japanese group are smaller in size, lighter colored and more slender. The flesh is whitish or light colored (except in the variety Early Red), juicy and the flavor is very sweet. Examples of the group are Champagne, Premier and Early Red.

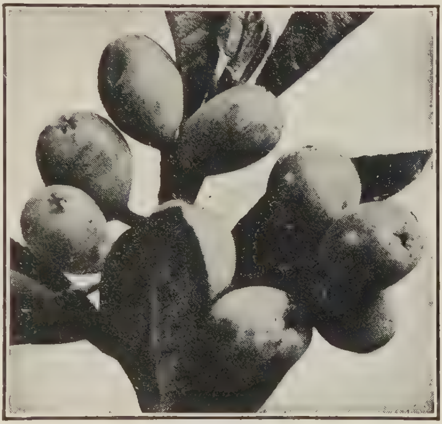
FIG. 165. Loquat. Fruiting stem

Soil. The tree will grow on many soil types. On poor soils, deficient in water, the fruits are apt to be too small, although they may be of good flavor. Size is an important factor in commercial fruits, hence it is important that the soil shall be either naturally rich or can be maintained in good condition by the use of fertilizers and irrigation. Irrigation is needed in the Western states, but not under Eastern conditions where there is a greater rainfall. Planting on good clay loam soils which are well drained will avoid the use of large amounts of fertilizer. Sandy loam soils of good depth are ideal. In Southern California there are good orchards on heavy clay soils of the adobe type. In China, rich moist lowlands are esteemed. In Florida, the shallow rocky soils of the east coast have given good results. Deep sandy soils lacking in fertility are undesirable.

Propagation. Seedlings do not reproduce the parent, hence good varieties are perpetuated by budding or cleft-grafting; budding is usually preferred, seedlings being used as stocks. The quince stock is sometimes used for the production of dwarf trees. Budding is usually done in October or November, the buds used being from new wood which has lost its leaves naturally. A long bud is usually cut and about 1½ inches long which is somewhat larger than is used for the orange. An ordinary "T" incision is made in the stock. The bud is tied in the usual way. When the union takes place the stock is topped back 3 inches above the bud. It is sometimes difficult to force the bud into growth. It is often unwise to cut the string which holds the bud in place at the end of two to three weeks and leave the buds unattended. They may need re-tieing with a slack string or the string used should be loosened to hold the lips of the incision in place. In Florida cleft-grafting is more certain than budding. The young trees are staked in the nursery, and are sold as yearlings.

Planting is usually made in the spring, March and April, although it is sometimes done in fall, September or October. Trees may be transplanted with bare roots or balled, the latter being advisable if the trees are to be shipped any distance. When shipped with bare roots, the trees are usually cut back severely, the branches being reduced to stubs. In some cases, trees are planted 20 feet to 24 feet apart. In California, under irrigation, the common practice is to crowd the trees in rows 24 feet apart and 12 feet asunder in the row, the aim being to stunt the trees to cause them to produce more uniform and regular crops.

Orchard management. The tree is quite prolific, easily handled, and is apt to overbear. The growing of leguminous cover-crops is beneficial. It is inadvisable to stir the ground deeply while the crop is maturing. Clean culture is not advised. In California, stable manure is valuable. Condit advises that 15 cubic feet of manure be applied to each tree annually. On average California soils when the crop fails, nitrogen is usually the limiting factor and fertilizers rich in this element will usually return the best results. After trying nitrogen, the use of phosphoric acid is suggested and after phosphoric acid, potash. Soil fertility must be maintained at a high point if good crops are to be secured. In southern France, the trees do not do so well on soils which are over-moist in the winter months. In California, while the tree is more drought-resistant than citrus, the best results are secured when the land is irrigated as for citrus.

Pruning. The pruning given while the tree is small is to secure a good head of three to five main limbs, as outlined for the apple. The pruning of bearing trees thus far seems to have consisted largely of the removal of dead and broken branches and the opening up of the tree to admit the sunlight. The best time for pruning is in the summer after the crop is harvested. It should be remembered that the fruit is borne on the tips of the season's growth. The number of fruits in a cluster should be reduced to secure size. The thinning given usually consists of nipping the end off the cluster when the fruits are about one-half inch in diameter.

Diseases and insects. Pear-blight is the most serious. Advance is one of the most resistant of the varieties. Trees seems to gain resistance as they grow older. Black-spot or scab causes black spots to appear in the fruit and checks its development, rendering it unsaleable. Spraying with bordeaux mixture after the blossoms have fallen is suggested. Anthracnose (*Colletotrichum glaosporioides*) sometimes injures the flowers. Spraying the buds with bordeaux mixture 3:3:50 is advised. There are not many insects which cause serious trouble, although the codling moth, green apple aphis, San José scale and Florida wax scale may do some damage.

Bagging. The Japanese protect the fruit from insects and birds by bagging. Skillful men can cover 1,500 to 2,000 clusters a day with paper bags. It is usually done when the fruit is one-half inch to three-quarters inch in diameter, or later. It is not often done commercially.

Harvesting. Fruit is left on the tree until it is fully mature. This will frequently be ten days after the color is well developed. This permits the full development of the sugar and the flavor. Round-pointed fruit clippers are commonly used for clipping the bunches in harvesting. Pickers harvest from 600 to 900 pounds of fruit a day—twenty to thirty boxes.

Packing. Grading, packing and shipping are still in the experimental stage. The box thus far used holds about 25 pounds of fruit. Usually two grades are made. The largest come in one class and the remainder in another. Perhaps three might be made, the third being used for jelly or jam or other by-products.

Yield. The trees are expected to bear at five years and at ten years they should produce 200 pounds of marketable fruit. Four to 5 tons per acre is a good crop. A common average price, pre-war times, was about 5 cents a pound, the best and earliest fruit sometimes selling at 35 cents, the lower grades at 2 cents a pound.

RELATIVES OF THE LOQUAT

Capulin (*Prunus salicifolia*). This is a Central and South American cherry, about the size of a Bigarreau, flesh pale green, meaty and full of juice, of sweet flavor with a trace of bitterness and a stone somewhat large for the fruit. It does not equal our northern cherries, but might if it received attention. It should be hardy enough to grow in Florida, the Gulf Coast states and California.

Manzanilla (*Cratægus spp.*), A Central American haw, bearing a fruit about the size of a small apple, which can be grown well in Southern California in a rather dry climate. It is not as good to eat as an apple.

Canistel (*Lucuma nervosa*). This plant is nearly related to the Sapodilla and the Star-apple. The fruits have flesh which is soft, melting, and of very sweet flavor. It seems to be at home on thin, poor soils on the Florida Keys. So far it has not proven to be sufficiently hardy to be grown in California. Fruit ripens from December to March and consists of an oval to round, orange-yellow fruit about 3 inches in length. Flesh is somewhat dry, bright orange-yellow, somewhat mealy in texture, and may be likened to the yoke of a hard-boiled egg in appearance. The flavor is sweet, the aroma somewhat musky. Fruit is usually eaten fresh and will keep several days after being harvested. Trees are usually propagated from seed. The plants require three to five years to come into bearing. Trees attain a height of about 20 feet.

Sapote (*Calocarpum mammosum*). This fruit is often 3 to 6 inches long, russet brown in color, with a thick and woody skin, which covers firm salmon-red to reddish brown, finely granular flesh. A hard, brown, shining seed which is easily removed is found in the center. The plant is commonly seen in Cuba and has been planted in the extreme southern portion of Florida, but it is believed that it does not like the limestone soil. It requires deep, rich soil and an adequate rainfall. It is considered to be as frost resistant as the Sapodilla. In the case of the Sapote, the outer husk of the seed should be removed before planting. The seeds are sown in light, sandy loams and just covered with soil. The young trees may be expected to bear in five to seven years. Trees may attain a height of 30 to 65 feet. Fruits ripen in summer. They are usually harvested when mature, and are allowed to ripen in a cool place. They can be shipped to northern markets. The flesh may be eaten or made into sherbet or into jam; hence, the name ''marmalade fruit.''

Green Sapote (*Calocarpum viride*). The flavor of the fruit is finer and more delicate than is that of the Sapote. The tree is productive, ripening its fruits from October to February. These can be shipped readily. The plant is somewhat frost resistant and is more likely to thrive in Florida than the Sapote. It is also on trial in California, but it is doubtful whether it will survive temperatures below 27 or 28° F.

The Mamey (*Mammea americana*). This fruit may be grown in Florida as far north as Palm Beach. The tree is less susceptible to frost as it matures, the young plants being quite susceptible. This fruit is not reported as succeeding in California. The tree may attain a thickness of 3 or 4 feet and reach 40 to 60 feet in height. The fruit is usually 4 to 6 inches in diameter; roundish, with a russet-colored, somewhat rough skin, about one-eighth inch in thickness. The fruit contains one to four large seeds which are embedded in bright yellow flesh which is juicy but of firm texture, somewhat like an apricot. The fruit is eaten out of hand or is prepared in the form of sauces, preserves or jams. The fruit ripens in the summer. Seeds are usually used to propagate. They are sown in light sandy loam soils upon which the tree seems to flourish, although they prefer a rich, well-drained loam. Varieties may be propagated by budding as performed for the Mango or by in-arching. The trees come into bearing at from six to seven years of age.

CHAPTER LXIX

THE MANGO

The Mango (*Mangifera indica*) has been in cultivation a long time. It is as well known over the whole tropical world as the apple is known in the temperate world. Writing in the fourteenth century the Turkoman poet, Amir Khusrau, said, "The mango is the pride of the Garden, The choicest fruit of Hindustan. Other fruits we are content to eat when ripe, But the mango is good in all stages of growth." Popenoe states that "At the present time the mango is a fruit of greater importance to millions throughout the tropics than is the apple to temperate North America." A grafted Alphonse Mango is as far superior to an ordinary seedling mango as a McIntosh apple is superior to a seedling crab apple. The fruits vary from the size of an ordinary plum to fruits 4 to 5 pounds in weight. In color, some are green when ripe, others deep yellow or apricot, with yellow or orange flesh, juicy, melting, rich and luscious in the case of the best varieties.

The tree is evergreen. It may be a low-growing shrub, in fact almost prostrate, or it may attain a height of 70 or more feet under favorable conditions. Usually the tree grows erect with a spreading dome-shaped top. Budded or grafted trees do not attain the size of seedlings and the size of the latter varies with the soil.

Varieties. There are hundreds of varieties. Some are regarded as excellent in flavor, while in others the taste or odor is so strongly of turpentine as to be inedible. It is claimed by those who have acquired the habit of eating mango that "while there are those who may not like them because of the smell of turpentine, there are those who have come to like turpentine because it reminds them of the joy of eating mangos." There are dessert and culinary varieties. The culinary varieties are preserved, made into jams, pies, sherbets, iced drinks, chutneys and used in a number of ways.

Climate is of prime importance, much more so than soil. In California, a dry climate seems to stunt the tree, but this causes it to bear at an early age and yield abundantly. Under such conditions it needs considerable irrigation, but given the latter the growth may be satisfactory on sandy, warm soils. The frostless regions back from the coast may be better suited to the crop than the vicinity near the sea, because the latter is too cold and there is not sufficient heat to ripen the fruit. Thus far the mango does not appear to have been considered as a promising fruit for commercial planting in California. It is more promising in Florida.

When young the plants are easily injured by frost, but when grown they will endure a temperature of 27 or 28° F. for a short time, without serious injury. The rainfall is important. The best crops are grown where the weather is dry and sunny, when the plants are in bloom and when they are ripening their fruits and where there is an abundant supply of moisture between these periods. A well marked dry season as above indicated is necessary to secure abundant crops. Regions with 30 to 50 inches of rainfall and little of it while the plant is in bloom are sought.

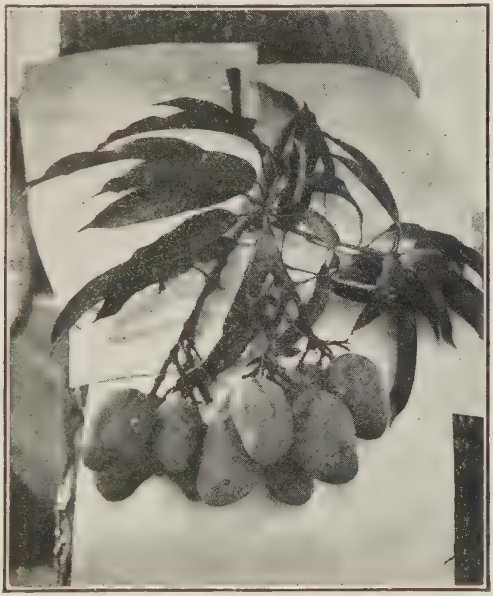

FIG. 166. Cluster of Fruits of Mango (*Mangifera Indica*). Bayeux, Hayti
Bronx Park Bot. Garden, N. Y.

Soil. In India, the best soil is a deep rich alluvial loam which contains a high proportion of sand, and is rich in humus. In Porto Rico, deep, rich, sandy loam soils induce rapid growth and large-sized fruits. In Jamaica, it thrives on low, dry limestone hills in the southern part of the island. In Florida, the shallow sandy soils which overlie the limestone appear to be well adapted to the crop and do not require as much fertilizer as is required to grow the avocado under similar conditions. Clay, if well drained, is satisfactory. The trees may thrive on wet ground but they will not bear any fruit. Good drainage is essential.

Propagation. Budding is the mode most frequently advised for propagating in America. Commercially in Florida, grafting and in-arching onto pot-grown two-year-old seedlings is practiced. In India, in-arching is practiced. Seedlings are sometimes used for reproductive purposes, some of them breeding fairly true to type. Some writers state that for orchard purposes the propagation of distinct varieties by budding is the only satisfactory course. Seeds of any variety are used. Frequently those of the common or turpentine mango are planted, on account of their low cost. Owing to the fact that the seeds lose their viability on drying, they must be planted soon after their removal from the fruit—within a few weeks. The husk of the seed is removed and it is planted in a 5-inch pot, being lightly covered with soil. Some seeds have several embryos and will send up several shoots. The strongest one should be allowed to grow. Seed sown in midsummer should make plants fit to set in the nursery in early fall. In Florida these are set out the following April to June when the diameter of the plant is about that of a lead pencil and at just the time the plant is sending out a new set of leaves it may be budded.

Budwood and bud. The budwood should be as dormant as possible. The bud stick should be vigorous, healthy, round, smooth and straight. The bud should not be cut from the most recent growth, but from the growth just previous to it. This wood will be of a grayish cast, not green, and should have hardened somewhat and be about the same age as the stock. The bud should be from 1 to 1½ inches long. It is inserted into an ordinary T-shaped incision and is tied in place by strips of tape, made of cheap muslin which is boiled in a mixture of 1 pound of beeswax and one-quarter pound of resin. If the bud union is satisfactory the top of the seedling is removed in three or four weeks. The cut is made some distance above the bud. It is generally considered difficult to secure a good stand of buds.

Top-working. Old trees are top-worked by first removing some of the main limbs to induce a growth of suckers or sprouts and then one or more of these is budded as outlined, or grafted with scions which are the tip ends of small branches of grayish fully matured dormant wood. The graft is held in place with soft cotton string. The top of the stock and the scions are wrapped in oiled paper for twelve to twenty days, when it is opened at the bottom end to admit light. In fifteen to twenty days more the scion may begin to grow and the paper is removed.

In-arching. Seedlings are grown in pots or boxes and when a year old are ready to in-arch. When about one-half inch in diameter, the box containing the seedling is fixed securely in the tree which is chosen for propagating purposes. A suitable twig is selected and about a foot below its apex about 3 inches of bark is removed from one side of the shoot. A corresponding piece is removed from the side of the seedling, perhaps 6 inches from its base, and the two cut surfaces are fastened together and bound into position with waxed tape and the whole covered with wax to exclude the air. Usually this is done at the beginning of the rainy season. In six to eight weeks a union is usually effected. The scion is then severed from its parent, the top of the seedling removed, and the plant is ready for transfer to its new home.

Races of mangoes. The mangoes are grouped into races which vary considerably in their traits. The following grouping is tentative for the common types seen in Florida:

1. Mango is represented in Florida by No. 11. The fruits ripen early and are subject to anthracnose.

2. Manga: The fruit of the Manga are of better flavor than Mango races and are not so subject to anthracnose. They keep better and the trees are more productive; the fruits ripen later than Mango. This race is common in southeastern Florida, being represented by Amarilla or the peach mango; also by the apple mango and Bombay. Probably the Eleanor belongs with it.

3. Filipino: This race is of very good quality, but is usually unproductive. Seedlings of this race are known as Philippines

in Florida. Cecil and Cambodiana are both varieties belonging to this race.

Pollination. Pollination and fruit-bud formation are two of the big problems in growing Mangos. Some varieties have a high percentage of perfect flowers, and these usually set good crops; others have few perfect flowers and these do not produce such heavy crops. The trees set a wealth of bloom. In some cases a single panicle may have 4,000 flowers, of which in some varieties but 2 to 3 per cent are perfect, while in others 60 to 70 per cent may be perfect. It is not necessary that all should be pollinated. In a perfect flower we see the ovary in the center with a single fertile stamen, sometimes we may find two; there may be other "false" stamens, but these bear no pollen. The anther produces little pollen, and it is probably transferred by insects to the pistil. Which insects are of importance is an economic problem. Most of the pistils seem to secure their pollen from their own anther. Cross pollination does not seem to be common. The practical problems are (1) to determine which insects are necessary or whether any are; (2) how to control the formation of fruit buds, since so many varieties are unproductive; and (3) what factors in food supply and moisture supply affect or control the reproductive functions.

Planting. The usual distance is 30 to 35 feet apart, each way. The planting is done in April and May. If not in active growth, the young tree may be set any time, provided the weather is warm. Large holes are usually made, 2 to 3 feet wide and 2 feet deep. Manure, bones and fertilizer are sometimes put into the hole. The trees are usually 18 inches to 3 feet tall and one-half inch in diameter when set. Budded trees are straighter and more attractive than in-arched trees, the latter are crooked and appear weak. The trees should be shaded after planting and well watered.

Cultivation and manuring. Cultivation is given as outlined for citrus. In California, irrigation will need to be practiced. The velvet bean, Lyon bean, cowpea and the Bonavist bean are regarded favorably as cover crops. Each variety will have to be studied in each locality before much definite advice can be given. For the first few years the plants may be well manured with well-rotted manure. After they come into bearing it is another problem. Manuring may need to be stopped entirely. Frequently there is great difficulty in getting the trees to bloom, and it is necesary to resort to all kinds of expedients to check vegetative growth and to encourage fruit-bud production. This embraces the withholding of fertilizers and manure; at certain times fertilizers are not applied while the trees are in bloom, nor in fall and winter. In Cuba, a 3:10:10 fertilizer is sometimes used, and in Florida the plants seem to respond to an application of potassic fertilizers. Usually little pruning is given other than to shape the head of the tree. A widespreading top is encouraged and some Florida growers aim to keep the center of the tree open.

Time of bloom. When the first crop of bloom is destroyed certain varieties may set another crop of blooms. Sometimes in Cuba, trees have come into bloom four times in a season. Some varieties, however, will bloom but once in the season; others as Sandersha and Julie in Florida may be in bloom for three or four months from January to May.

Insects and diseases. In one place or another the following insects are troublesome: Mediterranean Fruit-fly (*Ceratitis capitata*); Queensland Fruit-fly (*Dacus tryoni*); Mango Fruit-fly (*Dacus ferrugineus*) and Mexican Fruit-fly (*Anastrepha ludens*). These fruit flies behave in the same way as they do on other fruits. The flies lay eggs in the fruit, from which the larvæ emerge and feed in the flesh, rendering it inedible and causing decay of the fruit. The usual mode of control is to try to poison the fruit-flies at such time that they live on the leaves, using some arsenical compound sweetened with molasses or some saccharine compound. Thus far, the results have not been all that is desired; and a search is now being made for parasites which will control these insects. The addition of molasses or sugar to arsenate of lead reduces its adhesive power. Red Spider and Thrips do damage and various scale insects attack the trees. Treatment is as used on citrus.

Anthracnose (*Colletotrichum glœosporioides*) causes the blossoms to fall off, and later it may attack the fruits, causing them to drop. Control consists in spraying with bordeaux mixture, 5:5:50, giving several applications, the first as soon as the first buds appear and repeating every fourth day as the inflorescence continues to lengthen. This usually takes ten to fifteen days. Sometimes four to six sprayings are given. The spraying aids the foliage, but is of little value in controlling blossom blight, for if the disease appears while the tree is in bloom the blossoms may be destroyed. Favorable, dry weather at the time of bloom is necessary to prevent infection, or else immune varieties must be sought. Rot due to *Bacillus mangiferæ* attacks the leaves, twigs, branches and fruit in South Africa. There is no control.

Bearing. The trees usually come into bearing in three or four years after planting. They take a longer time to come into bearing in Florida than they do in the tropics. In Florida, D'Or and Julie, both dwarf varieties, may bear in two years after planting; Haden in four years; Mulgoba in four to six years; Malda and others have taken over ten years. Some which bear small fruits will mature several thousand fruits in a season. Those which produce larger fruits may bear but a few hundred. Mulgoba is in the latter class. Mulgoba in Florida may bear a crop but once in four years. Amini is more regular. Sandersha may produce a crop annually. Cambodiana and Pairi are both more productive than Mulgoba.

Size of fruits. The American Pomological Society has fixed the following sizes for Mangos: Very small, below 4 ounces; small, 4 to 7 ounces; below medium, 7 to 9 ounces; medium, 9 to 13 ounces; above medium, 13 to 15 ounces; large, 15 to 20 ounces; very large, 20 to 24 ounces, and extremely large, above 24 ounces.

Harvesting. The fruit is harvested when fully mature. For local sale Sandersha may be allowed to soften slightly; for shipment it must be harvested before it is fully colored. It must not be allowed to become soft. In some varieties, as Amini, when overripe the flesh around the seed acquires a disagreeable flavor. The fruit is cut from the plant with shears, leaving a short stem on the fruit. If pulled the sap may run from the stem end and disfigure the fruit.

Storage. The late varieties can be stored or shipped with safety. Fancy Mangos are shipped from India to London and from Jamaica to London and from the French West Indies to Paris. There is very little loss in transit. Different varieties behave differently in storage. Each variety must be studied separately, not only in regard to its cultivation, management, problems of pollination, but also as to the way it is ripened and stored. The fruits must reach the consumer with all their flavor and aroma and then they will sell themselves. Mangos may be held in warm storage at a temperature of from 80 to 83° F., or in cold storage at 40 to 47° F.

Amini: Fruits ready to eat when harvested have kept four days in good condition in a warm room and eleven to eighteen days in a cool room. Fruits hard ripe with good color kept seven to ten days in a warm room and were ready to eat twenty days after being placed in a cool room and kept six days longer.

Cambodiana: Tree-ripe fruits will keep in a warm room five days. Those hard-ripe and colored when picked kept twenty-six days in a cool room but were not so good as those ripened on the tree.

Sandersha: Fruits picked before they began to soften kept twelve days in a warm room. Those kept in a cool room remained in good condition five weeks, at which time they were of better flavor than fruits ripened on the tree.

Alphonse can be kept two months if properly stored, while Pairi will keep but a few days.

Packages. The package used is the tomato crate, which holds six baskets. Each basket will hold six to twelve of the fruits. Each fruit is wrapped in paper and a layer of excelsior is placed below and above the fruits so that thirty-six of the largest fruits are held in one crate. The shipping season from Florida is from July to October, with the main movement in August and September. The development of this fruit commercially is now taking place. It is being shipped to the Northern markets from Florida and some growers are quite enthusiastic about the prospects.

CARISSA OR NATAL PLUM

Carissa, Amatungula or Natal Plum (*Carissa grandiflora*) is an evergreen shrub desirable for its foliage and bloom as well as fruit. The flower is like a large single Jasmine. The fruit is about the size of a medium-sized plum of a brilliant crimson color and pleasant acid flavor. It may be eaten out of hand but is usually used in the manufacture of jams, sauces, jellies and pickles. It contains 12 per cent of sugar. The plant is growing in California where it has been tardy in bearing, and in Florida and the Hawaiian Islands where it is highly esteemed. Its tardiness in bearing may be due to lack of the proper insects to effect pollination, but since some plants are productive while others are not the former should be propagated. The plant can withstand several degrees of frost and is fairly drought-resistant. It is used as a hedge plant, since it stands shearing. It is grown on a variety of soils from sand to clay. Seedlings are easily grown in flats containing a light, sandy loam soil. These do not come true to type, hence varieties must be perpetuated by layer-

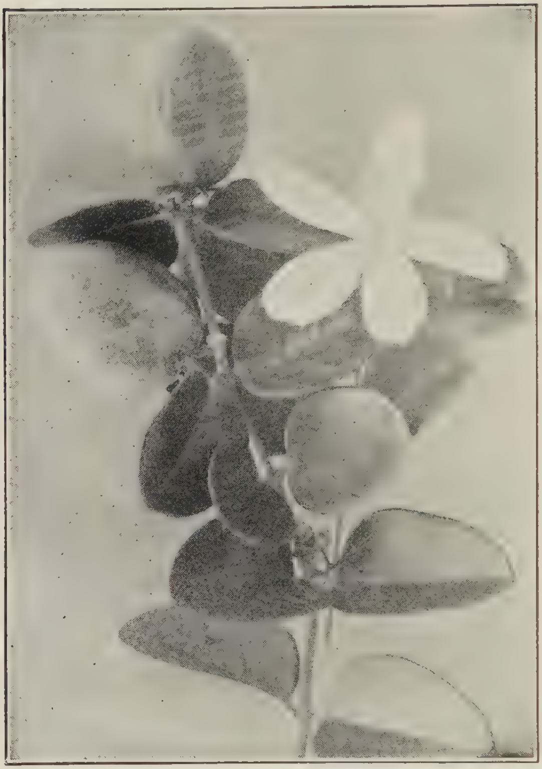

FIG. 167. Natal Plum (*Carissa grandiflora*). The fruits are scarlet when ripe and in flavor resemble raspberries. The flowers are pure white and delightfully fragrant

Photo by Wilson Popenoe, U. S. D. A.

ing or cuttings or by shield budding onto seedlings. The bush is not difficult to train, producing a shapely plant if left to itself.

The Karanda (*Carissa carandas*) may be grown in California and Florida. Its fruits are used in India for pickles and preserves.

CHAPTER LXX

THE OLIVE

The olive (*Olea europea*) is an evergreen, a native of Syria and other parts of Asia. It was transferred into southern Europe and brought by the early Spanish Fathers to California, where it has grown bountifully. Many of the trees these men planted are still alive and yielding excellent crops; from them have been propagated some of the best pickling olives known. The industry is extending from California into Arizona and New Mexico and bids fair to be of increasing importance. It was estimated that in 1919, California had about 2,000,000 olive trees of bearing age and as many more not in bearing, on 37,412 acres of land. Spain in the same year had 3,581,289 acres, an acreage equal to that usually planted to potatoes in the United States.

Climate. The olive is not adapted to the tropics and does best in sub-tropical regions. A clear, dry, warm climate is essential. The coast region of California with its cool breezes and fog is not so good as inland. On the coast the tree is subject to disease. The climate is the main controlling factor with this crop. It is not considered good practice to plant the tree where the temperature often falls below 20° F. The tree has survived a temperature of 10° F. in California. Frost at blossoming time, or a temperature of 28° F. when the young fruits are formed or when they are maturing, may destroy the fruit.

Soils. The soil best suited is a light, friable, well-aerated, warm and well-drained rich loam, well supplied with lime. Heavy, clay and poorly drained soils are unsatisfactory; usually the crops borne are proportionate to the fertility in the soil. The olive does not thrive in a soil deficient in moisture. In dry territory a monthly irrigation is given during the dry season to insure a good yield, but in other regions better supplied with moisture and on rich loams regular irrigations may be unnecessary.

Propagation. Plants are propagated from seeds, tips, long cuttings, sprouts, suckers and layers. As with other fruit trees, budded or grafted trees are looked upon as the most desirable to plant, being more robust and longer-lived than seedlings, but they are the most difficult to secure. In the first place the seed germinates slowly, frequently taking two seasons, and the budding or grafting takes time. Germination is aided by soaking the seed for several hours, often twelve to twenty-four, in a 10 per cent solution of caustic potash. To determine the right length of time a seed should be broken from time to time. The seeds should be taken out of the lye before the lye penetrates to the seed. The seeds are then stratified in moist sand until March or April when they are planted relatively thickly in the nursery row. Clipping off the apex of the olive pit is a great aid to germination. Seed so treated will germinate in a few weeks. The seedlings are transplanted from the seed bed into the nursery when about two years old. They are budded the following season and grown two years more so that five years may elapse before the tree is ready for the orchard. The trees may be grafted near the surface of the ground. Graft hybrids are possibilities in this plant.

Tips and cuttings. Tips are relatively easily rooted. During the dormant period, ends of the small lateral branches are taken off, about 4 or 5 inches long. The lower leaves are removed and the upper ones partially removed. These are then rooted in sand and transplanted to the nursery row. For cuttings, wood is cut 12 to 14 inches long. This is taken from two- and three-year-old wood or more, and is planted in the nursery row. Cuttings at least three-quarters of an inch in diameter are preferred. Layers can be secured by the common process of layering, the undersurface of the layer being cut in various places to stimulate the production of a callus and roots.

Grafting and top-working. Seedlings may be grafted in the nursery when they are one year old by means of a side or a whip-graft. This is done in early spring before the sap flows, or the budding may be done in the spring when the sap is moving. Grafting is usually made at the surface of the ground. Worthless trees may be top-worked, either by grafting or budding in the smaller branches, or the tops may be removed in part and grafts inserted into the cut branches. Often suckers are allowed to start, and these are grafted or budded as though they were seedlings.

Varieties. Mission is the most popular "all-around" variety. Manzanillo is next. Sevillano and Ascalano, on account of their large-sized fruits, are esteemed in certain localities. These four are the commercial list. Other varieties are: For oil—Atrorubens, Nevadillo Blanco, Pendoulier, Precox, Razzo and Rubra; but these are not largely planted. For pickling—Lucques, Macrocarpa, Polymorpha and Regalis. These all have their defects which have held them from prominence. For drying—Atroviolacea and Sweet olive. For stocks—Redding and Chemlali. They resemble the wild olive.

Planting and care. The trees are usually planted 25 to 28 feet apart, but some growers prefer 30 to 35 feet, although the trees will not require 25 feet of space for the first twenty-five years of their life. Seedling trees may grow 40 feet tall and need more room. Cultivation consists of plowing early in spring and continuing until September, at which time a cover crop may be sown. An application of fertilizer may be made in spring before plowing and another in fall as cultivation is ceasing. Irrigation usually begins in May. The water is turned on five times at intervals of thirty days, although with young trees more water is given than with older. Cultivation follows each irrigation, as soon as possible. An ample supply of moisture should be present in the soil at the time of bloom and when the fruit is almost of full size.

Pruning. When a tree is planted, it is usually cut back to about 18 inches from the ground. Four or five branches are left which are shortened to about 4 inches each. The leaves are stripped off. The customary later management is twice a year during the next three years to examine the trees and prune if need be, to secure good shape. After this, annual prunings are needed to thin out surplus wood or to direct the growth. Wild trees usually bear once in two or three years. California experiments show that trees unpruned during their first five years grew ten times as large as trees severely pruned each winter, were of better shape and commenced to fruit earlier; just sixty-one months after planting, 75 per cent of the unpruned trees were blooming profusely. The fruit is borne on one-year-old wood like the peach, and the same wood never bears twice. By the fifth or sixth year the framework of the tree is made and a paying crop should be received. In some regions it is customary to give a severe pruning every second year. This was practiced in districts where the olive fly and scale were prevalent, and seemed to be a satisfactory way of handling the problems. It is generally advised, however, to prune annually, removing wood which bore a crop the previous year and thinning out one-third to one-half of all weak branches and removing all injured or ill-placed branches, in this way letting in an ample supply of light and air to maintain the tree in a state of good bearing at all times.

Diseases. Olive Knot (*Bacterium savastanois*) is the bacterial disease that causes knots or warts on the trunk, branches and leaves of the tree, which so weaken the tree that it is rendered unprofitable, if not destroyed. It seems to spread most readily in the warmer districts and on the young trees on the rich soils. To control, quarantine and cut out the infected areas as for fire blight. Black Scale (*Saissetia oleæ*) is most destructive in the regions near the coast, but it does little or no damage in the dry regions. It may cause the business to fail. A good location is necessary for success.

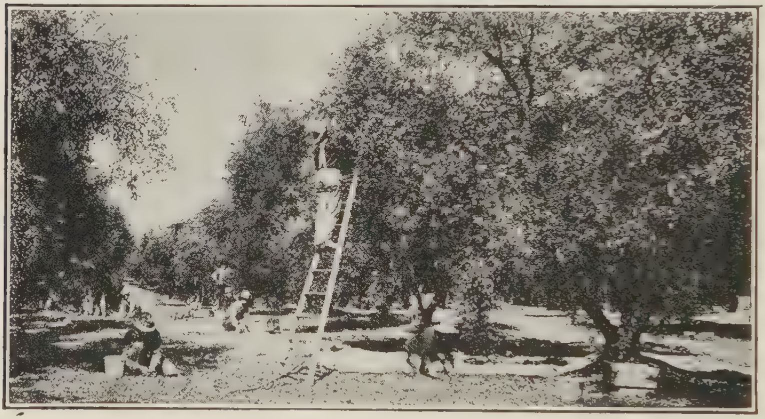

FIG. 168. Harvesting Olives in California

Harvesting. Olives for pickling are usually harvested in October. The picking season extends over a period of two months. The time of harvest depends upon the object in view. For green pickles the fruits are gathered as soon as they have reached full size and before they show a particle of color. For ripe pickles they are picked when purple to black in color. When required for oil they are allowed to turn black and should then come off. They depreciate in value if they become soft. The finest oil is made from olives gathered just before they begin to soften.

In harvesting olives for pickling, the fruit must not be bruised. They are usually picked by hand and in Europe are dropped into a pail half filled with water to prevent injury. If they are to be moved far they are carried in vats filled with water or lye. It usually costs from $15 to $20 a ton for harvesting the pickling fruits and a half-cent a pound or $10 a ton for the ripe fruit when it is to be used for oil. Oil olives are sometimes gathered by means of rakes which have wooden teeth, but beating the trees is poor practice. The imported pickled olive is harvested green, or before it is ripe. The California olive may be harvested green or be allowed to ripen and then be pickled. The growers contend that no more unripe olives should be allowed to be sold unless sold as unripe fruit. The green olive contains 6 to 10 per cent of oil, the ripe olive 25 to 40 per cent. The last two days of ripening are the most important, since in that time the oil content increases markedly.

Olive Oil. To obtain olive oil only fully ripe, sound fruits are used. They may be pressed as soon as harvested or spread not over 3 inches thick on trays, piled one on another. Access to a current of air is provided. This permits the water to evaporate out of the fruits. They are then crushed under stone or iron rollers. The crushed fruit is pressed—in all three times. The oil secured by light pressure is of the highest grade, that from the second pressing is next, and a third yields a lower grade. The pomace yields a still lower grade that is used in the manufacture of castile soap, the residue for fertilizer. Unsound, moulded, or fermented fruits will spoil the oil. Frozen olives may be picked and pressed at once; if held twenty-four hours they are unfit for use. Overripe fruit gives an inferior oil. Usually not more than 35 gallons of oil are secured from a ton of olives, although with heavy presses 40 gallons may be secured. In other words from 50 to 65 per cent of the oil is recovered from the olive.

Olives for pickles. Ripe olives are required, but not soft. About six pounds of olives are used to make a gallon of pickles. Olives are often stored in brine for one to four months before pickling. It is advisable with Manzanillo, Sevillano and Ascolano. The olives are cleaned and graded and the selected fruits are then soaked in lye, either sodium hydroxide or potassium hydroxide, or water until the bitter flavor is extracted. The nature of the lye treatment varies with the variety, the size of the fruit and the degree of maturity. Some varieties have thick skins and are extremely bitter; such require a longer time in the lye than thin-skinned olives which contain less bitter principles. If water is used it must be frequently changed, the process requiring thirty to ninety days. Water is seldom used, the lye treatment being safer and quicker. Average fruit is kept four to twelve hours in a solution of caustic potash of the strength of 1½ pounds to 12 gallons of water. By this time the lye has penetrated almost to the pit of the olive. The olives are exposed to the air to permit them to darken in color. With bitter olives the treatment is repeated. With very ripe or soft olives it is necessary to have salt in the lye solution.

If the fruit is firm it is then washed in water to remove all trace of the lye, this taking several days, the water being changed frequently. If the fruit is soft the water should contain 2 per cent of salt. The fruit is then put into brine, the strength of which is increased from time to time beginning with 4 ounces of salt to a gallon of water and increased to 6, 10 and 14 ounces to the gallon, depending upon the rapidity with which the salt is taken up by the olives. Finally the olives are put into boiled brine of a strength of 5 pounds of salt to 12 gallons of water in which they are sterilized at 240° F. for 40 minutes, and stored. The process takes three or four weeks but can be reduced by the use of hot wash water in removing the lye. The large sizes are used for pickling, the small ones for oil.

For long keeping the olives must be heated in sealed cans or bottles, which enables them to be kept indefinitely. Owing to the presence of the *Botulinus* bacillus in one pack in 1918 it is tentatively understood that all ripe olives shall be heated to 250° F. to insure freedom from this danger.

Standard for ripe olives. The index of maturity is the oil content of the flesh of the olive. The tentative standard is: For Mission olives and other common varieties, except Manzanillo, Ascolano and Sevillano, the minimum oil content shall be 17 per cent. For Manzanillo 15 per cent. If less oil be present the fruit is unripe. In some places the large-fruited varieties, Ascolano and Sevillano, are gathered while immature and such cannot be labeled ripe olives.

Probable yield. Usually the trees take five to seven years to come into bearing. A small yield, 5 pounds per tree, may be secured the fourth year; the next year it may be double, and at ten years the tree may produce 60 to 70 pounds of fruit. Twenty-year-old and older trees have produced 250 pounds to 650 pounds of fruit per tree; 1,000 to 8,000 pounds of fruit per acre is secured in profitable orchards. An average estimate for the state of California is about 1.4 tons per acre in 1911, at which time about 85 per cent of the crop was used for making oil and 15 per cent for pickles. In one orchard, the average yield per tree was as follows: 155 trees, average per tree, seventh year, 4.5 pounds: eighth year, 5.1 pounds; ninth year, 5.8 pounds; tenth year, 7.1 pounds; eleventh year, 7.4 pounds; twelfth year, 7.7 pounds; thirteenth year, 5.8 pounds and fourteenth year, 9 pounds. A twenty-acre orchard bore in 1911 1½ tons per acre; in 1912, 2¼ tons, 1913, 2½ tons; 1914, 5.6 tons. The latter is a good yield.

CHAPTER LXXI

THE PAPAYA AND ITS RELATIVES

The Papaya (*Carica papaya*) is erroneously called pawpaw. It is related to the pumpkins and melons and attains a height of 20 to 30 feet. The trunk is fleshy, usually unbranched, and bears a number of large, soft, long-stalked leaves on its apex. Sometimes it branches. The branches may be removed and used as cuttings for propagating purposes.

The fruits are something like a melon and vary in size from 3 to 30 inches in length and up to 20 pounds in weight. It is as popular as a breakfast dish in the tropics as muskmelons are in temperate regions. The flesh is salmon-pink or yellow. It is eaten as a dessert, salad, boiled as a vegetable or made into preserves, jellies and pies. There are several varieties of fruit, some are sweet, others insipid; some have excellent flavor, others lack flavor.

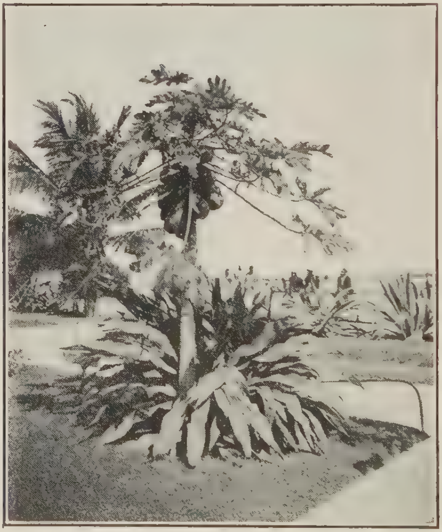

FIG. 169. Papaya tree (*Carica papaya*) bearing fruit. Nassau Bahama
Bronx Park Bot. Garden, N. Y.

Distribution. This fruit has spread over the tropical world. It is second only to the banana in Hawaii. It is thoroughly naturalized on the Florida Keys, and is grown throughout southern Florida. It has not reached to great success in California, although the plant may live in the foothills of Southern California for a couple of seasons.

Climate. A warm climate is essential. A little frost may injure the plant although in a mild winter the plants have survived northern Florida. Cold rains are detrimental, especially if the soil drainage is deficient, causing the plants to rot at the base.

Soil. A rich, loamy, well-drained soil is necessary. Rich hammock soils are preferred to pinelands in Florida. The plants are rank feeders and on soils deficient in nitrogen, organic nitrogen should be applied. Chicken manure has proven valuable. The plants require considerable moisture.

Pollination. Some plants are male, others bear female flowers and still some bear both male and female flowers. Usually more males than females are produced in a lot of seedlings. The female or pistillate flowers must be pollinated in order to bear fruit, and this is done by insects. Female plants stay female for life but a male or staminate plant may change and bear both male and female flowers for a time and later may bear nothing but female flowers. The hermaphrodite forms can pollenize themselves. Hence, there is an opportunity to select the best. By ensuring self-pollination a reasonably large number of good quality and productive seedlings are secured, and these reproduce themselves with the same degree of accuracy that is secured in tomatoes.

Propagation. The plant may be treated as an annual. The seedlings are raised by sowing the seed in a sandy loam soil about one-half inch deep. The seedlings may be potted off when the third leaf is formed and later transplanted from the pots. Damping off must be avoided. A good percentage of the seedlings are apt to be males and these may be budded over to females.

Grafting. Seeds planted in the greenhouse in February produce seedlings of ample size for grafting in March. When about the thickness of a lead pencil the top is cut off the seedling, leaving a stock about 5 to 10 inches tall. At this time the trunk is still solid and has not the cavity seen in older plants. It may be split with a sharp, thin knife and a cleft graft from a desirable tree is inserted.

To prepare grafts. The top is cut off a desirable tree and this forces the growth of small shoots from the buds in the leaf scars on the trunk. These small shoots are cut off, the leaves reduced, and the graft inserted. For some unexplained reason grafting has not proven a success in Florida. It causes degeneration of the plant in three or four generations of plants. If propagated for three or four generations as indicated they will bear nothing but small, worthless fruits, hence the Florida growers have gone back to seedlings.

Planting. The plants are set not less than 10 feet apart each way, one male to about ten females. They are short-lived. Trees grafted in March are often planted in May, or even late in April. These may come into bearing in November or December and may be left to bear for a year. Growth is very rapid during the first year. The plants will not usually remain in profitable bearing more than three to five years under favorable conditions.

Insects and diseases. The Papaya Fruit-fly (*Toxotrypana curvicauda*) causes trouble in Southern Florida. The fly lays her eggs in the center of the fruit by means of a long ovipositor. The larvæ live on the seeds and later on the flesh, destroying the fruit. To control, clean up infested fruits and develop varieties in which the fleshy area is very thick, so that the ovipositor cannot reach the seed-bearing area. The young larvæ cannot live on the flesh. The Mediterranean fruit-fly is sometimes destructive. The Papaya Leaf Spot (*Pucciniopsis caricæ*) sometimes attacks the foliage in the winter. It is recommended to spray with bordeaux mixture.

Harvest. In Florida, the fruits usually ripen from December to June. The fruit is harvested as soon as its surface begins to turn yellow. Since its skin is thin and membranous and the fruit is large and heavy it is difficult to ship the fruit if allowed to become fully ripe. For long distance shipment the fruit must be picked green, and if picked too soon it does not ripen properly. A hundred or more fruits are gathered from a tree during its life. The fruits may be shipped, wrapped singly in paper and packed singly in a corrugated cardboard cylinder. The cylinders are packed in single tier crates and shipped under refrigeration.

RELATIVES OF THE PAPAYA

The Mountan Papaya (*Carica candamarcensis*) is a native of high elevations in Colombia and Ecuador and is much more resistant to frost than the Papaya. It withstands a temperature of 28° F. without serious injury and bears fruits which are used for stewing and for making jams and preserves. It is hoped that it may be used as one parent of a hybrid papaya which may be sufficiently hardy for Southern California and the Mediterranean.

The Purple Granadilla or Passion-fruit (*Passiflora edulis*) is a somewhat woody climbing plant, which bears white and purple flowers and oval fruits, 2 to 3 inches long, of a deep purple color when fully ripe. There is an outside brittle shell inside of which are many small seeds each surrounded by yellowish juicy pulp, the flavor of which is somewhat acid. This fruit is important in Australia and is slightly grown in California, where it bears abundantly. It is not so productive in Florida, perhaps due to some lack of knowledge of pollination. Bumble bees or humming-birds may be factors in the transfer of the pollen. The older flowers are fertilized by pollen from younger flowers, the pistils not being receptive when the pollen is shed. It withstands light frosts, the younger plants are more easily injured than those more mature. It is grown on all kinds of soils, sometimes on very poor sandy soils, in which case liming and heavy manuring may be advisable. The land should be well fitted and kept well manured. Seedlings may be raised in flats in light soil. The seeds germinate slowly. When six months to a year old they may be planted out of doors. Cuttings of fairly matured wood, about 6 inches long, may be easily rooted in sand without bottom heat, and same have borne fruit in pots when two years old.

In Australia the plants are set out in spring in rows 10 feet apart, the plants 12 feet in the row, like grapes. The rows run north to south. six and a half foot posts are placed 18 inches deep, 24 feet apart to carry the trellis which consists of two wires fastened to the tops of the posts. The plants are trained to a single stem until they reach these wires when two to four leaders are developed and run on these wires in both directions. The vines are most productive when four or five years of age, after which time they decline in vigor. They bear early, two crops a year. The first of these may be reduced in size by heavy pruning and the removal of the fruits which stimulates the production of new fruiting laterals which bear the later crop. The fruit is gathered at least twice a week as it begins to ripen. It can be kept in a cool dry place for a short time. It is graded according to size and color and packed in boxes in layers.

The Sweet Granadilla (*Passiflora ligularis*) is perhaps the best flavored fruit of this genus. It is a strong climbing plant and should be sufficiently resistant to cold to live in Southern Florida and perhaps parts of California, in both of which it is now on trial. It will not withstand more than two or three degrees of frost and it bears but one crop a year.

The Giant Granadilla (*Passiflora quadrangularis*). This plant is the largest fruited member of this genus. It is more tropical in its requirements than any of the above. It will grow in Southern Florida but not in California. It is propagated by means of seed, or 10- to 12-inch cuttings which should be of well-matured wood and should be planted in sand. Hand pollination may be necessary if the proper insects are not available to do the work.

CHAPTER LXXII

THE PINEAPPLE

This plant (*Ananas sativus*) is native of the tropics in America. The plants bear a rosette of stiff leaves about 2 to 4 feet tall. When twelve to twenty months old the plants send up a single flower stalk, about 2 to 4 feet tall. The flower stalk bears small lavender colored flowers, which produce a compound fruit known as a "head" or pineapple. The fruit is fleshy and weighs from 1 to 15 pounds and is surmounted by a rosette of stiff leaves. The head is the edible portion. It is the pineapple of commerce. The stalk bears a head but once. A new stalk may come up from the same plant and bear another pineapple.

In 1850 pineapple growing was started in southern Florida, but it was not until adequate facilities for transportation were furnished that the industry became established. It has been severely tried by freezes at intervals—as those of 1894-95, 1899, 1905 and 1917. The fruits from Cuba and the West Indies and the Hawaiian Islands have been and are the important factors in supplying the American trade. During the World War production in Florida declined. The freeze of 1917, high production costs, difficulty in maintaining humus and in securing fertilizers, the planting of weak slips and nematodes were factors in forcing men out of the business.

Climate and soil. Since pineapples are injured by a temperature lower than 30° F. a frost-free site is essential for success. Formerly a considerable acreage was located on the Florida Keys and along the East Coast from Fort Pierce to Miami. A small area on the West Coast at Punta Gorda, and limited areas north, were grown under sheds. The experience secured will be of value to those contemplating growing this crop. On the Florida Keys the soil may be little more than decomposing coral rock with an inch of leaf-mold, but on the mainland "hickory scrub," a dry, sandy soil richer in humus and more retentive of fertility than "scrub-pine" is preferred. The soil must be well drained. This is so important that in Hawaii in seasons of excessive rainfall, the soil may be dynamited every 20 feet to a depth of 4 feet to facilitate drainage without disturbing the surface soil. The rainfall should be at least 50 inches a year, and more if the soil is very well drained. The pineapple survives drying in the air for months and frequently vigorous plants will be found destitute of roots. The essentials are: (1) A frost-free site; (2) the best of air-drainage; (3) a well-drained soil, free from nematodes and if deficient in humus it must be built up before planting; (4) good roads and shipping facilities.

Excess of manganese and lime. The pineapple will not thrive on soils rich in lime or manganese. Soils containing 3 per cent of manganese cause the leaves to turn yellow and the young fruits to turn pink long before they are ripe. The fruits so grown are extremely acid and unpalatable. The effect of an excess of lime in the soil is equally injurious. The leaves turn yellow and the small fruits fail to develop their normal color.

Fertilizers. In Florida large quantities of fertilizer are applied, usually three or four applications a year, varying from half a ton to a ton per acre at each application. No rules apply but certain practices are in vogue in a number of locations as follows: A fine ground steamed bone is generally a good source of phosphoric acid and both bone meal and basic slag are of value. If acid phosphate is used, about half a ton of lime per acre may be needed every second year or so with it. Bone black and acid phosphate are both doubtful sources of phosphoric acid. Dried blood, cottonseed meal and castor pomace are good sources of nitrogen and nitrate of soda may be used in a limited way for the first year, if used with caution. As a source of potash both the high and low grade sulphate of potash are better than muriate of potash, but kainit should not be used. Tobacco stems may be used.

Applying fertilizers. The Florida Station reports that within three weeks or as soon as possible after setting, the plants should receive a tablespoonful of cottonseed meal per plant, in the base of the leaves to keep out sand. Six weeks later broadcast a half-ton per acre of a mixture analyzing 5 per cent nitrogen, 4 per cent available phosphoric acid and 10 per cent potash and repeat this every three months for the first eighteen months; after this make two applications a year of from 1,200 to 1,800 pounds each, one in February or March and another as soon as the summer crop is cut. Other growers make three applications —1,400 pounds per acre as above in February; the same amount again as soon as the summer crop is cut, 1,000 to 1,200 pounds per acre of tobacco stems are applied in the fall or early winter. The tobacco does not push the growth but enables the plants to harden and better withstand cold weather.

Tillage. On the Florida Keys little tillage is possible. Tall weeds are removed as they appear, but the bed is short-lived. On other soils the scuffle hoe is used. As soon as planted, and after applying the fertilizer the surface soil is scuffled over about an inch deep. The frequent stirring keeps the weeds under control. Under sheds tillage is usually given more frequently than for plants in the open. The men hoeing avoid walking among the plants for fear of breaking the leaves which are extremely brittle. By the Cuban method of planting horse tillage is possible.

Pineapple sheds. In parts of Florida, sheds may be erected to protect the plants in winter from frost and in summer from the heat. The plants freeze at a temperature of 32° F. This destroys only the leaves and not the heart of the plant. Under sheds the plants have endured a temperature of 25° F. without serious injury. The sheds are usually built 6 to 8 feet high. With the increased expense only the highest quality varieties as Cayenne and Queen can be grown, and most of the sheds have been abandoned.

Propagation. New varieties are secured from seed. According to Webber it takes ten to twelve years for a seedling plant to come into bearing. The commercial method is by means of suckers, slips, crowns and stumps. A sucker is a shoot or small plant which develops in the axil of a leaf below the fruit stem. When these occur near to the ground they quickly develop into strong plants. In the normal course of events a plant which has matured an "apple" in June will produce two to five suckers by the middle of September. Slips are small plants which form just below the fruit. They require a year longer than suckers to mature a crop. Crowns are the top knot of leaves on the fruits. They are obtainable only when the fruit is used nearby as for canning. For market purposes the fruit is shipped with the crown on it. Plants grown from crowns require two years to mature fruit. Stumps produce a very vigorous growth. They may be laid in furrows like sugar cane and half or wholly buried in the sand. They are preferred to suckers in land containing high manganese content. Ratoons are left in the field to replace plants which have borne a crop. It is seldom that they are sufficiently numerous to fully maintain the stand. Selection of the strongest, healthiest and most desirable plants as the source of supply of slips is imperative.

These should be marked at fruiting time. The reported superiority of Cuban slips is due solely to the fact that they are taken from strong, vigorous plants.

Planting suckers and slips. In planting suckers and slips, a few leaves are removed from the base of the new plants. After drying a bit, slips are usually set 2 to 4 inches deep and suckers from 3 to 5 inches deep, the soil is firmed round them so that the bud is about an inch above the surface of the ground. They can endure a long period of drought and make roots when sufficient moisture is available.

Varieties. The varieties may be grouped under three heads:

1. The Queen Group with the Golden pineapple as the type. The fruit has yellow flesh, pointed eye sloping upward from the sides, deep yellow fruit, flavor rich and sweet. The plants are usually not adapted to open field culture as Black Ripley, Egyptian, Golden, Green Ripley, Pernambuco and Abachi.

2. The Cayenne Group with smooth Cayenne as the type. The flesh is light-yellow, the eyes broad and flat, not elevated at the nipple. The leaves are smooth or serrated. The plants are strong, upright, vigorous growers.

3. The Spanish Group with the Spanish pineapple as type. The flesh is white, the eyes flat but elevated at the corners of the bracts. The leaves are strong, stiff and serrated. The quality of the Spanish variety might be improved but the plants are healthy and vigorous and well adapted to field growth. The fruits mature from June to August, are of medium size, two to five pounds each, and oblong but tapering in shape. Spanish constitutes more than 90 per cent of the total plantings of Florida.

For canning, a fruit cylindrical in shape is desired since more large rings can be secured than from a conical fruit. Cayenne is one of the best of the fancy pineapples, bearing large sized fruits, very juicy and of rich, sweet flavor.

Planting. From 8,000 to 15,000 plants are needed per acre. The custom is to lay the land off in beds about six to eight rows wide, so that hand work can be done with the hoe without walking through the beds. Breaking of the leaves is detrimental. The plants are set in checks. Red Spanish is planted 18 to 22 inches, Queens 20 to 22 inches and Portò Rico 30 to 36 inches. On the thin soils of the Florida Keys the plants are put in wherever there is sufficient soil, and are quite irregular. The Cuban system is to plant in double rows, 10 inches by 12 inches with a 6 foot space separating each pair of rows.

Growers troubles. As soon as planted sand is apt to blow into the bud of the sucker and cause trouble. This is prevented by dropping a handful of cottonseed meal in the crown of each plant as soon as set. Tobacco stems, bone, blood or tankage are also used.

Heart Rot, Bitter Heart. The apple becomes bitter and may rot. Often in a rainy season the heart of the fruit appears to be water-soaked and in time decay sets in. The remedy is to handle the fruit less roughly, pack and ship promptly.

Spike: Longleaf. In this case the leaves do not develop and broaden at their base, but grow lengthwise. They are not healthy. This is due in some cases to the improper use of fertilizer or to an excess of lime in the soil.

Blight or red wilt has been the most serious and destructive disease in Florida. It has been the chief cause of the decline of the industry. The tips of the leaves turn red and later wilt. The disease is due in a large measure to nematodes (*Heteroderæ radicicola*), minute, parasitic, ground worms, which infest many light soils of the South. The remedy is to sow the land to Iron cowpeas, velvet beans, natal grass, the latter preferably, or other immune crop for two or three years and starve them out, and incidentally build up the humus content of the soil, before replanting to pineapples. Since nematodes are widely distributed throughout the world, nematode-resistant pineapple varieties would be a boon. Spanish is more resistant than Cayenne and an immune variety might be secured.

Red Spider. This insect sometimes attacks the base of the leaves, causing them to rot if allowed to go on unchecked. Throw a handful of tobacco dust in the bud of the affected plant. Repeat in ten days if need be.

Mealy Bugs attack the base of the leaves near the ground, also the bud and the slips. Apply tobacco dust if the insects are discovered while at the base of the leaves; if not discovered until later, spray with fish-oil soap, resin wash or resin compound or one of the distillate oil emulsions.

Scale. A scale may cause trouble in dry localities. It appears on the under surface of the leaf, which shows through to the upper surface as a yellow spot. Spray as for mealy bugs.

Harvesting. The pineapple fruit contains very little starch. The stump and the fruit stem are rich in starch. As the fruit matures, the starch in the stump and stem are changed into sugar and transferred to the fruit so that in the last ten to fourteen days before the fruit gets ripe its sugar content increases from 4 per cent to 11 per cent and in some varieties to 14 per cent. Fruit harvested while green may change its color from green to yellow but develops no more sugar; hence this fruit cannot compare with that which is allowed to ripen fully before harvesting. For this reason canned pineapple made from the highest flavored varieties, allowed to become fully ripe and canned within twenty-four to forty-eight hours, possesses the best flavor. With ample refrigeration in transit and prompt packing and loading, pineapples may now be left on the plant until they are "ruddy-ripe" and have assumed a reddish-yellow color, but have not turned full yellow or become soft.

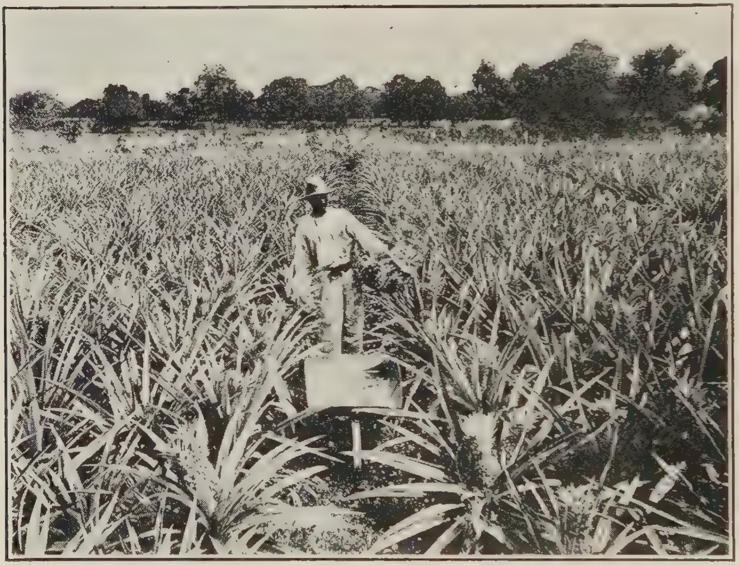

FIG. 170. Harvesting Pineapples at Kingston, Jamaica
Bronx Park Bot. Garden, N. Y.

The Spanish pineapples are usually seized by the crown and with a sharp quick jerk are quickly parted from the stem. The Cayenne, and more often the Abachi and Porto Rico, are apt to break off in the flesh if handled in this way; hence these varieties are usually cut off with a knife. In large plantations, small cars drawn by mules or gasoline power are run on tracks through the plantation. This is advisable when the fruit is hauled a considerable distance. The tracks are 2 by 4 inches or 3 by 3 inches scantling. The men picking the fruit are equipped with duck mitts and leggings which are large enough to give ample protection. Under sheds, the fruit is gathered and carried into the alleyways by the arm full.

Packing. At the packing-shed the fruit is graded or sized and all injured fruit is discarded. Each fruit is wrapped in heavy glazed paper that will not absorb moisture. Certain standard sizes are recognized. As an example, the number of pineapples and size are indicated in a form of pack below:

PACK FOR SPANISH PINEAPPLE

Number to crate	Number of layers	Number in each end	Size in inches, approximate
18	3	3	5⅛ by 6⅞
24	3	4	4⅝ by 5⅜
30	3	5	4½ by 5¼
			4¼ by 5$\frac{7}{16}$
36	3	6	4⅛ by 4⅞
			3$\frac{15}{16}$ by 4⅝
42	3	7	3¾ by 4$\frac{3}{16}$
			3⅝ by 4¼
48	3	8	3½ by 3¾
			3$\frac{7}{16}$ by 4

When packed the fruit should not rattle in the crates. The crate should fill flush or a little more with the ends and partitions of the crate. The crate is then nailed up with 4-penny cement-coated nails. One man can nail as fast as two can pack. The end of the crate is stencilled with the name of the shipper or grower, the variety and number of the pack. A lithograph label is often used. Extra fancy fruit may be packed in excelsior.

Loading the car. A minimum car is 300 crates but 360 crates are often loaded. Six crates are placed on the flat sides 2½ to 3 inches apart across the end of the car. A slat the width of the car, one-half by 3 inches, is laid on and along the front edge of each layer and a nail driven into each crate. Layers are placed five or six high in the ends of each car. A passageway of about 3 feet wide is left between the doors. This is braced with material 5 inches by 1 inch, to prevent movement. By placing the slat always on the front edge, a tip is given to each crate which materially aids in preventing movement. Shipments in carlots by all-rail route usually take five or six days from Florida to New York and if by boat a day or two more.

Storing. Ripe pineapples may be held at a temperature of 32° F. for a month. In some tests they were held for forty-five days before they showed a slight withering. When held at 36° F. the flavor deteriorated in about thirty-five days. Hence, there is no reason for harvesting the fruit green. Green fruit owing to poor flavor injures a market; but ripe fruit, properly matured and rich in sugar, will sell for a dollar a crate more and stimulate demand.

Canning and other uses. A great canning business has been developed in Hawaii. For canning, cylindrical fruits weighing 3½ to 5 pounds each are preferred. The whole process of canning is carefully managed. The cores are used for glacé fruits. The juice which would otherwise be wasted is bottled or made into syrup for soda fountains or is used in canned pineapples which need additional sugar. The fibre of the pineapple leaves may be used for making cloth. The stumps offer a source for starch if needed.

CHAPTER LXXIII

THE PITANGA AND THE POMEGRANATE

The Pitanga or Surinam Cherry (*Eugenia uniflora*) is a small shrub which may grow from 5 to 20 feet tall. It bears fruit resembling a small tomato, and possessing a spicy, acid flavor. The fruits are esteemed in Florida and Southern California for making jellies. The plant may also be used as a pot plant.

Soils. The plant appears to succeed well on shallow sandy soils in Florida, but in Brazil, to which it is native, it is generally found on clay or clay loams.

Management. Propagation is usually from seeds. These are frequently allowed to germinate under the bush, especially when the fruits are allowed to fall; or they may be sown in light,

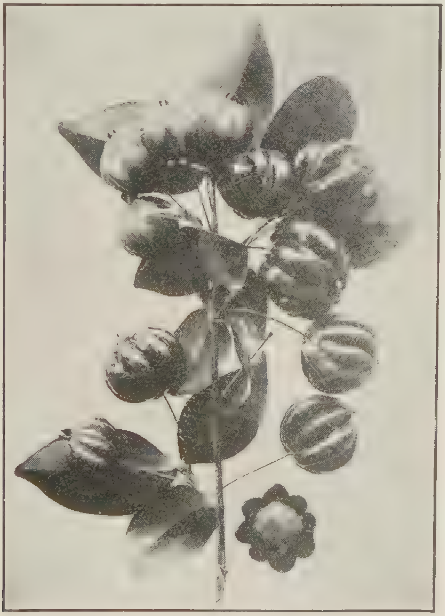

FIG. 171. Fruiting branch of the Surinam Cherry (*Eugenia uniflora*)
Photo by Wilson Popenoe, Miami, Fla. U. S. D. A.

sandy soil in flats, covered to a depth of about an inch. The plants vary considerably in color and the flavor of fruit. One race bears fruits with a deep crimson color. Varieties cannot be developed until better methods of propagation are devised. Whip grafting is reported as successful. Pollination is accomplished by bees and other insects. The plants are usually put out after they have attained the height of about a foot. From their present behavior in California, they seem to have considerable drought-resisting ability. So far, no special requirements in regard to cultivation have been worked out. The plants need to be kept well supplied with water at the time the fruits begin to color, to insure size.

The plant receives relatively little attention. In their native habitat in Brazil they are frequently used as hedge plants. The fruits are usually borne during the early spring in southern Florida and frequently there is a second crop later in the summer. In California the season is late summer.

Relatives of the Pitanga. The Jambolan or Jambolan Plum (*Eugenia jambolana*) succeeds in Southern California but in other parts does not ripen its fruit except in protected places.

The Rose Apple or Jambo (*Eugenia jambos*) attains a height of 20 to 30 feet and bears fruit from one-half to 2 inches in size, somewhat pear-shaped. It is hardy in California as far north as San Francisco and in Southern and Central Florida. The fruits are used in jelly making and in confectionery.

The Grumichama of Brazil (*Eugenia dombey*) bears deep crimson fruits about the size of sweet cherries. These are eaten fresh or preserved. The tree is in cultivation in Southern California and in Florida.

THE POMEGRANATE

The Pomegranate (*Punica granatum*) is a small tree or large shrub, with somewhat thorny, slender branches. It is quite apt to sucker. In order to preserve its form as a tree, the suckers must be removed frequently. It may attain a height of 15 to 20 feet. The plant is highly ornamental for at least nine months of the year. It has bright, glossy leaves and blooms of flaming red appearance, which are carried from April to September. The white-flowered varieties are generally undesirable, having poor flavor. The fruit matures in September to November, but may be allowed to hang until

January. When the plant is not in bloom the fruits are an attractive sight. The plant may be used for hedges, in which case the suckers are allowed to grow to keep the hedge thick. The plant may be grown in a tub, under glass in the north.

The fruit is often the size of an orange but somewhat flattened. It has tough, leathery rind and varies in color from pale yellow to purple. The rind is always thin, but it is lined with a layer of rag or pulp which may be relatively thick or thin. Inside this are found the large seeds coated with pulpy flesh. The requirements of the ideal commercial fruit are: (1) That it shall be medium to large size, pink or bright red. (2) That it have a thin, tough rind, being well adapted to shipping. (3) That there be an abundance of bright red or crimson flesh and a small amount of rag or pulp, for this is apt to be bitter in flavor. (4) The seeds must be tender, easy to eat and small in proportion to the covering of aril or juicy matter which surrounds them. (5) The juice must be abundant and the flesh rich, vinous and sub-acid.

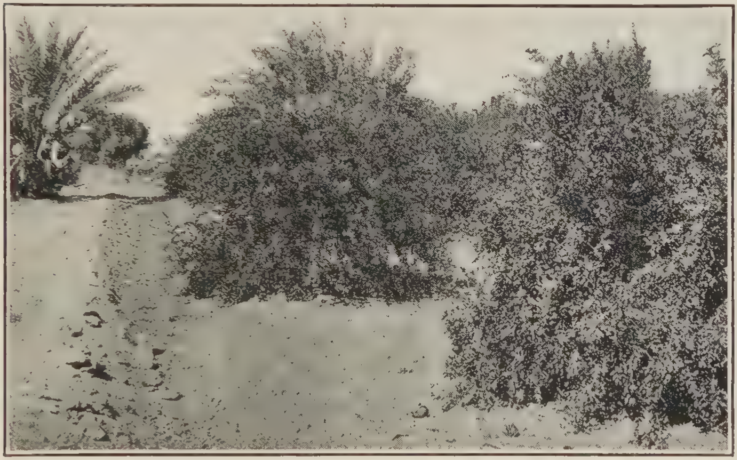

FIG. 172. Pomegranate orchard at Indio, Calif. Also showing a bearing data palm on the left

U. S. D. A.

Distribution. The plant is now receiving attention as a marketable crop in California, Arizona, Georgia, Alabama, Nevada and Utah. It can be grown over a much larger area, from Georgia to Florida in the Eastern states. If there were an adequate demand, it could be relatively easily propagated. The plants will thrive as far north as Washington, D. C., but fruiting appears to be uncertain north of North Carolina. It is worthy of cultivation in the home orchards over the Southern and Western states. The trees and bushes are usually long-lived. In France, there are specimens growing in Paris which have been in fruit for over two hundred years.

Varieties. Two classes have been made, according to the color of the blossom,—white-flowered and red-flowered.

Climate. The plant does best in regions of long, hot, dry summers. It will thrive better in the higher altitudes than on the sea coast,—in altitudes of 4,000 feet between the 41st parallel of south latitude and the 41st parallel of north latitude. In fact, it may be classed with the fig and the olive. No climate seems to be too hot for it and yet it is more hardy than the citrus fruits. It cannot endure temperatures lower than 8 to 15° F. without serious damage. Zero temperatures cut it to the ground. There is marked difference in the varieties and their ability to resist frost. The sour varieties are more hardy than the sweet.

Pomegranates from desert regions where the total amount of heat is high, have the best flavor and color and excel in quality. They may be planted between figs and dates. When grown near the coast in California where they are exposed to cool sea breezes, the plants do not bloom well or set much fruit and that which is produced is usually sour, tart and poorly colored.

Soils. Pomegranates are grown on a variety of soils from pure sand to heavy clay. On the lighter soils the yield is usually less. On the heavier soils, the color is apt to be poorer. It is sometimes grown on alkali soils, being apparently relatively resistant to alkali, but it cannot produce its best under such conditions. It seems to do best on deep soils of fairly heavy nature, those upon which pears would thrive; or, if anything, those which are slightly heavy and a little too wet for pears.

Propagation. Propagation is relatively easy from seed, cuttings and from layers. Seeds are usually planted in flats in a cold-frame and grown under heat until they are well established. The plants do not breed true to type; hence, for the propagation of varieties, cuttings or layers are made. Layering may be resorted to as for the grape, but involves more work than cuttings. Hardwood cuttings of one-quarter to one-half inch diameter and 10 to 12 inches long, are made in February or March and planted in nursery rows 3 feet wide. The plants are spaced 8 to 10 inches in a row. Cuttings should be covered almost to their entire length, the top eye being left exposed. The cuttings may be left in the nursery row for one or two years before planting. If needed, softwood cuttings may be used. These should be taken as soon as the wood is formed and rooted in green-houses or in beds. They may be expected to root in a few weeks and may be planted the following spring.

Planting. When used as a hedge, the bushes are set 6 to 8 feet apart. The suckers tend to fill in the space between and make a compact hedge. For orchard purposes, the plants are placed 14 to 18 feet apart each way. Trees may be planted in the spring as soon as the ground will permit working. Usually the earlier the better, February or March in California.

Cultivation and irrigation. The land is usually plowed and fitted before planting and plowing is repeated each succeeding spring. The land is stirred every two, three or four weeks to maintain a mulch. To give the best results, pomegranates seem to require as much water as peaches or apricots. California advice is that if the water requirements of oranges can be set at 50 inches including the rainfall, pomegranates may require 35 to 40 inches. The water is usually applied in two to five irrigations throughout the growing season. The furrow system is generally used. Some growers irrigate until July only, while others continue until September.

Pruning. The usual custom is to cut out all interfering branches and dead wood. Some growers prefer to treat the plant as a bush, others attempt to make it into a tree with a single trunk. The general preference is to treat it as a bush. The fruit is borne on the terminals of short spurs produced on slow-growing matured wood. After a term of years, this wood loses its fruiting habit so that new wood must be brought in to replace it. Little fruit is borne in the interior of the tree. In other words, it appears on the outer rim, so that heavy shortening in of the older wood is undesirable for it may cut off two or three years' crops.

The California method is as follows: Cut the tree to a height of 24 to 30 inches at planting. On this develop three to five scaffold limbs which should be pinched back to make them stocky, starting the lowest limb 8 to 10 inches from the ground. In the second season, shorten the limbs back about three-fifths of their length, and the following spring allow two or three primary branches to develop on each scaffold limb. Keep the main stem and frame free from suckers at all times. In this way, a strong, compact tree will be formed at the end of two or three years, at which time the tree will start to bear. The tree will grow slowly from fifteen to twenty years. Pruning should be confined to removal of suckers, interfering branches, dead wood, the thinning out of some of the older branches, which is usually done in the winter. If a bush form is preferred, three to five stems are selected instead of one.

Diseases. Sometimes the center of the fruit is found to be badly decayed, black in color, disagreeable in odor. This is known as heart-rot. The infection takes place in the blossom and survives until the fruit has matured when it causes the decay. No remedy is known. Sometimes the plant is attacked by certain insects as the citricola scale, the greedy scale and citrus thrips. Ordinarily these do little damage. Sunscald or sunburn sometimes causes the fruit to be irregular in growth.

Harvesting. Most of the fruit is harvested before it is fully ripe on account of the tendency of the fruit to split. In some varieties the fruit bursts wide open on approaching maturity. In others, it just cracks, both of which spoil the fruit. Several pickings should be made, the first usually beginning in October in California. This continues at weekly intervals for a month. Fruit should be clipped and not pulled off. It should not be bruised. It is usually picked in bags which are emptied into field boxes. These are hauled to packing-sheds where the fruit is brushed or wiped, sized, wrapped and packed.

Yield. Two hundred to 400 pounds of well-formed and well-colored fruit may be expected from a tree developed as outlined. Large ("Jumbo") fruits bring a premium. Small fruits sell at a discount. A large pomegranate, weighing 2 or 3 pounds, is desired. Some old trees have produced 400 to 500 pounds of fruit. The frame-work should be designed to carry such a load.

Packing and storage. The package used is the orange half box. These weigh 35 to 40 pounds, packed. Sizes vary from 24 to 110 per box. Fruit is held in cold storage where it will keep in excellent condition for five or six months. It ripens in storage and the quality improves, the flavor becoming richer, the rind thinner and tougher, the amount of rag diminished and the seed coats become more tender and edible. The fruit may be hung also in a dry room where it will keep for several months.

CHAPTER LXXIV

THE SAPODILLA, STAR-APPLE, WHITE SAPOTE AND TUNA

The Sapodilla or Naseberry (*Achras sapota*) is a compact-growing evergreen tree, which may attain a height of from 20 to 60 feet. It carries thick, glossy leaves and fruits resembling a russet apple. It makes a relatively slow growth, and is well adapted to pot culture. The plant is grown in Central America, in Florida as far north as Palm Beach, and is on trial in Southern California but so far is not a success. It may be grown along the sea shore. The fruits are used for dessert and are highly esteemed. They may be round, oblong, or conical, from 2 to 3½ inches in diameter. The skin is rough and russet in color, somewhat like that of a russet potato. The flesh is yellowish-brown when fully ripe. It has sweet and melting, juicy pulp, having the flavor of an apricot, and a characteristic, desirable perfume. The pulp has ten to twelve compartments and contains from none to twelve hard, flat, smooth, black seeds about three-quarters of an inch long. The fruit varies greatly in size and flavor. It is inedible until ripe. Some trees ripen their fruits in August and February, two crops a year, but there is sufficient variation in seedling trees so that fruits are procurable throughout the year.

Chicle. Chicle, which is the base of chewing gums, is obtained from the fruit, leaves and bark of the tree, principally from the bark. The latex is obtained by cutting the bark by making V-shaped incisions, one above another, so that the sap will flow downward in a continuous stream. It is extremely sticky and is usually caught at the base of the trunk in leaves or a simple container. Tapping usually begins in early September. Heavy rains stimulate the flow of sap. Large trees not previously tapped will yield 15 to 25 pounds of latex. Trees have been tapped for twenty-five years, but at the end of that time the latex yields only 25 per cent gum. The latex may coagulate spontaneously or by boiling. The gum secured if carefully prepared is white, but it is usually a dirty gray. It is kneaded after it is coagulated, to remove the water, and is marketed in blocks of 20 to 30 pounds. It was formerly used for electric insulation, but is now used entirely for chewing-gum, and the demand is exclusively in the United States. The wood of the tree is a dark, purplish-red, and is highly esteemed for cabinet work. The bark is sufficiently high in tannin to be used as a source of that commodity.

Propagation. The seeds are sown in flats, in light, sandy soil; they are covered about one-half inch deep. Germination may be expected in about a month. As soon as the plants have made two leaves they may be potted and held in the pots for one or perhaps two years. They may then be planted in the open ground, or if to be budded, they may be planted in the nursery about 18 inches apart in rows 3 feet wide. The budwood selected should be taken from the young branches and should have lost its greenish color and begun to assume a brownish tinge. Care should be taken to see that the eyes are well developed.

Shield budding is practiced as outlined for the Mango. The buds are cut, usually a little over an inch in length. If wood is left under the eye in cutting, it should be removed, unless it is held firmly in place. The buds should be tied in place immediately after insertion, waxed tape being used. The latex which escapes from the wound will soon collect around the point of incision and make tying difficult if not done promptly. The stock may be headed back in three or four weeks. The tape should be slackened so that the bud may start into growth, but not be removed until the bud has become well established in growth. May is usually the season for budding in Southern Florida, but the work may be done any time the stocks are in active growth. Layering is sometimes practiced in India.

Seedling trees. There is great variation in the size of the fruit borne by seedlings. Some weigh a pound while others weigh only two or three ounces. Some ripen their fruit at the time of year when it is particularly desirable, others when it is not. Some are very prolific, others are unproductive. Some are nearly seedless, some entirely so. Hence, there is great opportunity for selection of the trees. The large variation in the season of ripening results in ripe fruit being found in the markets at nearly all seasons of the year.

Planting. The trees should not be set closer than 25 to 30 feet. In some places they do not attain a greater height when full grown than 20 to 30 feet. As a rule little pruning is given the seedling trees. The general cultivation and care is as given for citrus. The trees do not generally come into bearing until six or eight years of age.

Diseases and Insects. The plant seems to be quite free from either diseases or insects, although the Fruit-flies (*Trypetidœ*) are sometimes serious pests.

Harvesting. For local use or for shipping short distances, the fruit is usually pulled from the tree. It is dropped into baskets or boxes in which it is sent to market. The retailer sorts out the ripe fruits from day to day as required. For shipment to greater distances, the fruit must be gathered while still hard. So far, it has been handled without any particular care in packing. Fruits will stand up for ten days or more. For shipment, the tomato crate holding six baskets, and each basket holding six good-sized fruits, is perhaps the best package. The fruit is generally eaten out of hand.

THE STAR-APPLE

The Star-Apple (*Chrysophyllum cainito*) is a native of the West Indies and will not tolerate frost. It can be grown only in southern Florida and the tropical parts of the United States or under glass further north. The fruit has no commercial standing as yet, but is capable of being made into a commercial fruit.

This evergreen tree grows up to 50 feet tall. It has handsome foliage, dark green above and varying from silvery white to golden brown beneath, hence the name Golden-leaf. The flowers appear in June to October, singly at the nodes; the fruits mature from February to April and are round, often 3 inches in diameter, with a smooth, tough rind about one-sixteenth inch in thickness and light green to purple in color. In the edible pulp are numerous black seeds and the star-shaped core which gives the fruit its name. The milky juice is astringent until the plant is thoroughly ripe. The fruit is best when allowed to ripen on the tree.

There are two kinds—those bearing fruit with a purple skin, and the so-called white, which is really a pale green shaded with purple. In the latter the fruit is larger and not quite so sweet. A well-manured sandy soil is regarded as best for their pro-

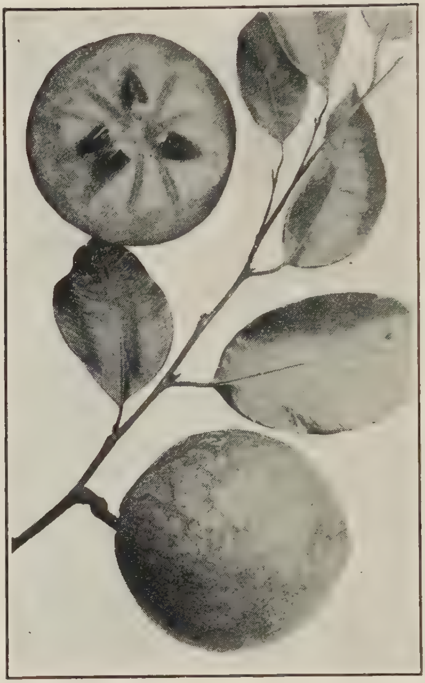

FIG. 173. Fruiting branch of the Star-apple (*Chrysophyllum cainito*)
Photo by P. H. Dorsett, U. S. D. A.

duction in Florida, while in Cuba they are found growing on clay soils. Any good loam soil will suit as long as it is not wet. Fertilizers containing potash are applied liberally. The plants may be propagated from seeds. Budding may be used. Well-ripened wood cuttings may be rooted in strong moist heat. Trees begin to bear in from four to five years after planting. The fruit may be held in cold storage and it ships very well.

THE WHITE SAPOTE

The White Sapote (*Casimiroa edulis*) may attain a height of 50 feet. It bears fruit which is as large as an orange and somewhat resembles the quince in general appearance. It has a yellow or yellowish-green skin, about as thick as that of an apple, under which is found soft, cream-colored pulp which is delicious although it has a peculiar flavor, generally sweet with perhaps a trace of bitterness. Fruits of some trees are large and of delicious flavor, others are small and bitter. There are usually five seeds which may be an inch by one-half inch, also light yellow in color. Sometimes only two or three seeds may be matured.

Distribution and soil. This plant is found growing through Mexico, and has been introduced into Southern California. It has been growing in Southern Europe for years and is relatively hardy. It also grows in the vicinity of Miami, Florida, where it seems to be at home. A well-drained, sandy loam soil is generally preferred in California, although it will grow on heavy clays, provided they are well drained. In Southern Florida it is found growing on the shallow sandy soils, which are underlain by the soft limestone.

Seedlings. Seeds are planted as soon as possible after removal from the fruit; usually in light soil in flats or singly in pots, being covered about 1 inch in depth. Under favorable conditions as to heat, they will germinate in three to four weeks. When the seedlings have reached a height of 2 to 3 feet they are usually transferred from the pot or flats to the ground and watered liberally to force growth. When they have attained a height of 3 feet, the terminal bud is sometimes pinched out to force branching; otherwise they may run up to a height of 10 feet, like a whip, in which event they are likely to be broken by the wind. If the seedling trees are desired for planting, it is necessary to induce the branching as outlined. Seedling trees may come into bearing when seven or eight years old, but many of them produce fruit which is worthless.

Seedling stocks. Vigorous, growing seedlings are preferred as stocks. They are budded when the stems are about three-eighths inch diameter at the base. Long buds are cut about 1½ inches long, the same being taken from well-matured budwood of an ashen gray color. The buds are tied with waxed tape and unwrapped two to four weeks later, when the wrapping is replaced or more loosely tied, so that the bud may start into growth. Sometimes it is advisable to girdle the stock to force the bud into growth, or cut it back 3 or 4 inches above the bud. In California, budding is usually performed in spring and summer when the stock is in most active growth.

Varieties. Two varieties, Harvey and Maechtlen, are more or less common in California, while Parroquia and Gillespie are described. Harvey bears the largest fruits, which may attain a diameter of 3½ inches, and the tree is quite prolific.

Management. The plant is quite drought-resistant, although in parts of California it is irrigated in the dry season. In California, the fruits ripen in September to November. In Florida they ripen in May, although in the tropics they may ripen from June to August. The fruit is gathered while hard but when fully mature. It is usually laid away for a few days to prepare for eating. It would require very careful packing for shipment. It is believed that it could be shipped considerable distances if properly handled. So far, the fruit is not commercial.

THE TUNA

The Tuna (*Opuntia spp.*) are now found in most of our eastern markets as well as in those where the fruits are grown. These fruits are cultivated in the Southwestern United States. The plants may attain a height of 10 to 25 feet. The fruits are commonly 2 to 3 inches in length, green to deep maroon in color, and contain soft, whitish, translucent pulp with numerous large, bony seeds. Because of their high nutritive value the tuna forms an important article of diet in many regions. Plantations are usually made on dry slopes of hills. Wet soils or heavy clay soils are undesirable. Joints are cut or broken off the plant and are planted in furrows 6 to 8 feet apart in rows 6 to 15 feet wide. Before planting, the cuttings are exposed in half sunlight for seven to fifteen days to allow them to wither. This facilitates rooting. No cultivation is given and the plants may be expected to bear in about three years and to remain in bearing for many years. As much as 18,000 pounds of fruit have been grown on an acre, without any tillage and on poor, rocky soil unfitted for other crops. The fruit contains 13 to 14 per cent of sugar so that this represents a production of 2,500 pounds of sugar per acre.

The fruits are eaten fresh, dried or prepared in various ways. There is considerable opportunity for the development of varieties. The fruits are shipped in boxes, in layers.

Chapters on nuts were written, but omitted to reduce the size of the book; also such fruits as cantaloupe, citron, watermelon, honeydew melon, were left for later treatment.

PART XII

VARIETY DESCRIPTIONS

TERMINOLOGY

A description of varieties is correct only for the place where the observations were made. The same variety behaves differently in different localities. It is impossible to write a description which will be correct for the whole of the United States. A Dunlap strawberry may be an excellent commercial berry in New York and perhaps in Ohio, and worthless in parts of Iowa. This is true also of apples and of every other fruit. It is, therefore, with considerable hesitation that the author inserts any description of varieties, in a work bearing the title of American Fruits. The omission of such a list might not be understood. The author trusts that this explanation may lead the fruitgrower to approach the problem of varieties with care, that if possible he will diligently search in his own locality and secure whatever evidence he can before planting any variety extensively. In regard to new varieties the fruitgrower should not be carried away with glowing accounts of the wonders of this or that one, realizing that even if such statements are true, it would not necessarily follow that they are true for his location. New varieties may be tried out in a small way; if one is in need of time and money for making a living he cannot afford to spend much on new and untried varieties.

In describing varieties of apples, certain terms have come into usage. For example, as applied to the tree, ''top'' is usually described as strong or vigorous, medium or weak in growth; it may be upright-spreading as in Baldwin; wide-spreading as in Rhode Island Greening; round-headed as in Early Harvest; and upright as in Red June; then again, it may be close or dense, as in Fameuse or open as in the Lady Apple.

The twigs may be slender as in Rome Beauty, or thick and stout as in Sutton.

The color of the bark after the leaves have fallen is variable; the buds vary in shape, some being pointed, others blunt at their apex. Leaves vary markedly in form. The fruit varies in size. In crab apples the fruits of Martha and Hyslop would be spoken of as large for crab apples, although they would be small for apples. We use the terms ''very large,'' ''large,'' ''above medium,'' ''medium,'' ''below medium,'' ''small'' and ''very small.''

Uniformity. When we speak of a variety as bearing uniform fruits, we mean that the fruits are relatively of one size. Uniformity is particularly desirable in show fruits.

Form. Apples are spoken of according to shape as round, flattened or oblate, conical, somewhat egg-shaped or ovate, oblong, or they may be between some of these forms. Then again they may be regular in form, or they may be compressed, elliptical, or the fruit may be ribbed or angular or smooth.

Stem. The stem may be long or short, slender or thick. Varieties having long, thin stems, such as Rome Beauty, usually hang on well; while those having short, thick stems are apt to drop quickly.

Cavity. The depression around the stem is technically called the cavity. It may be wide, as in Rome Beauty. This is usually spoken of as obtuse; or it may be narrow and of a very acute angle as in McMahon, when it is spoken of as acuminate. The cavity may be very wide, as in Northern Spy, Tompkins King, York Imperial, or narrow as in Black Gilliflower. It may be deep as in Jonathan, Northern Spy, York Imperial. Medium in depth as in Baldwin, or shallow as in Pewaukee.

Calyx. The calyx sometimes persists, although in the Siberian crab apples the sepals fall off. The calyx may be open in some varieties and closed in others.

Basin. The depression in which the calyx is set is called the basin. It may be shallow, medium or deep; narrow, medium or wide. It may be smooth or furrowed.

Skin. The surface of the skin may be covered with a whitish bloom which is easily rubbed off. It is very easily seen in McIntosh and Northern Spy; or it may be waxy and oily as in Lowell; or it may be of an unbroken russet as in the Russet apples. It may be rough, as in the case of Hubbardston and Tolman Sweet; again, it may be smooth. Some varieties have a little fuzz on or about the calyx.

Color. The fruit may be striped with one or more shades of red; it may be mottled or it may be green with a blush, or green.

Scarfskin. Sometimes this gives a characteristic appearance to the fruit; it is the coloring situated around the stem.

Core. If an apple is cut in two, we see the core, which is outlined by the visible core lines. It may occupy a greater or lesser extent of the apple.

Flesh. The color of the flesh may be white as in McIntosh and Fameuse; tinged with yellow as in Rhode Island Greening, Baldwin, Jonathan; greenish white as in Rambo, Fallawater. The flesh may be streaked with red as in Wealthy and sometimes McIntosh.

Texture and flavor. Texture is spoken of as firm, hard, tender, tough, crisp, breaking, dry or juicy; and the flavor as sour, sub-acid, sweet, sprightly, aromatic, astringent.

Quality. Varieties are usually referred to as poor, fair, good, very good or best.

Uses. Apples are spoken of as market apples, meaning they are suitable for general market; local market apples, which indicates that they may be used for nearby delivery, but are not well adapted to long distance shipment; dessert apples, which means they are desirable for table use; culinary apples, which means that they are of use for cooking purposes. Some apples are grown because they are good for baking.

Season. According to the time at which they mature, apples are spoken of as early, medium or late.

SUMMER AND FALL VARIETIES OF APPLES

Alexander. A Russian variety in cultivation one hundred years. Tree large to medium, upright-spreading to roundish, open and somewhat inclined to droop after it comes into bearing; hardy, subject to fire blight; fruit large, uniform, roundish conic; stem medium to short; skin moderately thick, tough, smooth, somewhat waxy, greenish or pale-yellow, often entirely covered with red or bright carmine; flesh nearly white with light-yellow tinge, firm, coarse, juicy, mildly sub-acid, fair to good. September to November.

The fruit must be handled very carefully, precooled before shipment or shipped the day it is picked, under ice; it is apt to crack and decay and is apt to drop. It has been supplanted to some extent by Wolf River.

Anisim. Is proving valuable in Minnesota where hardiness is a prime requisite. Tree a good grower, productive; fruit below medium, roundish conical, almost covered with dark crimson and heavy bloom; stem medium; flesh greenish-white. Early winter.

Arctic. Valuable for cold climates; hardy from Central Iowa northward. Tree vigorous, spreading open top like Tompkins King. Sometimes a shy bearer; fruit medium to large, oblate, sometimes somewhat conical, resembles Baldwin in size and color; stem short and rather thick; skin nearly smooth, yellow or greenish yellow, often almost entirely covered by bright red; flesh tinged with yellow, moderately coarse, crisp, juicy, mildly sub-acid, fair quality. Uses, market and culinary. October to February or later.

Benoni. A very good dessert apple, attractive in appearance, excellent in quality, but lacking in size. Tree comes into bearing while young, bears crop biennially, is rather large, erect to roundish, dense; fruit medium to small; skin smooth, orange-yellow covered with red; flesh yellow, firm, crisp, fine grained, juicy, pleasant sub-acid, good to very good. August to September.

Bietigheimer. Noted for its size and beauty. A good cooking apple but coarse, sub-acid; fruit extremely large, drops badly; tree strong grower but makes poorly shaped trees; bears early, frequently annually, moderately productive. Mostly used for home or market. September to October.

Bismarck. Resembles Alexander. Tree dwarfish, healthy, hardy, seems to be a reliable cropper and productive; quality poor. October to December.

Blenheim. Sometimes planted for home use. Fruit large to very large, yellow with red stripes, of excellent quality, in season with Twenty Ounce; the crop ripens unevenly, not a good cropper.

Borovinka. Resembles Oldenburg but in some places is not equal to that variety in flavor and quality. August.

Champlain. (Nyack, Sour Bough). Tree, good grower, strong, healthy, moderately long-lived, comes into bearing early, bearing usually biennial, sometimes annual crops; fruit good size, smooth, attractive, greenish yellow, suitable for dessert, excellent for culinary use. At least two pickings should be made. Fruit should be gathered while green; is grown to some extent along the Atlantic coast from New Jersey northward for local market. August to October.

Charlamoff. A Russian variety of Oldenburg type. Ripens a little ahead of Oldenburg. Of value for sections where superior hardiness is a prime requisite.

Chenango. An excellent dessert apple and good for culinary use; tree an early, regular bearer, hardy, healthy, long-lived, medium size; fruit yellowish-white striped with red; matures over a period of several weeks, hence is of value for home use but not for market purposes; is too tender to ship well. August to September.

Collamer. A Twenty Ounce, but of better color.

Constantine. Resembles Alexander, ripening about a week later.

Cox Orange. One of the best of the English dessert apples. Grows well on dwarf stock. Of value for home use. Tree moderate grower, medium size, productive; fruit medium size, red and yellow; decided aromatic sub-acid flavor, excellent quality. September to January.

Dudley. A very hardy and productive variety, resembling its parent, Oldenburg. Valuable for northern climates. Tree, small, spreading and drooping; fruit medium to large, uniform; skin thin, tender, pale yellow or whitish covered with a pinkish blush or stripes of bright carmine; flesh tinged with yellow, sub-acid, very good. September and October or later.

Early Harvest. An old variety. Well disseminated; grown for home use. Tree fairly good grower, medium size, upright-spreading or roundish; comes into bearing early, biennial or annual cropper; fruit pale yellow, medium size, sprightly sub-acid, of very good quality. Suitable for dessert or culinary use. July to August.

Early Joe. For home use only. Tree small to medium in size, slow grower, bears quite young, is an erratic cropper; fruit hangs well, medium to small, red striped, excellent flavor, suitable for dessert. One of the choicest apples grown. August to September.

Early McIntosh. A cross of McIntosh and Yellow Transparent, and ripens with the latter. Very promising.

Early Ripe. Tree good grower, upright-spreading, somewhat dense. comes into bearing early, biennial cropper; fruit medium size, yellowish, sub-acid, fair quality, suitable for culinary use. Is grown in the Atlantic Coast states for local market. August. Better varieties are available.

Early Strawberry. Tree medium size, moderate grower, hardy, healthy, comes into bearing early, regular cropper; fruit bright, deep red color. Useful for local market and home use, for dessert and culinary use. August.

Fall Pippin. The large, attractive, yellow fruits of this variety are fairly well known; excellent for dessert, especially suitable for culinary use. Tree strong grower, hardy, long-lived, eventually becomes very large, spreading or roundish, rather dense; subject to fire blight. Fruit large to very large, round to roundish oblate; stem medium to rather long; skin smooth, thin, greenish yellow, finally becoming clear yellow; flesh whitish or tinged with yellow, moderately firm, very juicy, sub-acid, very good;

foliage and fruit are quite subject to scab. Fruit does not ripen uniformly. September to January.

***FAMEUSE.** One of the most desirable apples of its season which usually extends from October to Christmas. Foliage and fruit are subject to scab. The tree is at its best in the Lake Champlain and St. Lawrence valleys to Quebec. Tree vigorous, upright-spreading or roundish, rather dense; fruit medium, roundish; stem medium to short; skin thin, tender, smooth, bright red to almost purplish black; flesh white, somewhat streaked with red, very tender, juicy, sub-acid becoming very mild later. Very good for dessert.

Since this variety has been propagated to a considerable extent by seedlings there are many slight variations, some being striped, others black red. In addition there are several distinct seedlings of promise such as McIntosh, Shiawassee, etc. McIntosh is more hardy than Fameuse and is now replacing it.

Fanny. An attractive red apple of dessert quality, desirable for home use. Tree reliable, annual cropper. September to December.

Golden Pippin. Fruit resembles Fall Pippin, being large, coarse-grained with sub-acid flavor; suitable for dessert or culinary use. Trees are not being grown to any extent in nurseries. September to January.

Golden Sweet. Grown for home use. Tree hardy, bears rather young, good grower; fruit clear yellow, rich, sweet, very good. August to September.

***GRAVENSTEIN.** Good size, attractive appearance, excellent quality and is perhaps unexcelled for culinary use; it holds high rank in Nova Scotia and in Central California and is found more or less scattered through the Eastern and the Pacific Coast states. Is generally self-sterile in California. Delicious, Yellow Newtown and Esopus best pollenizers. Tree hardy, large, vigorous, upright-spreading to roundish, open; subject to canker, sunscald and winter injury in the crotches; fruit large to above medium, fairly uniform in size but not in shape, oblate to roundish, ripens unevenly, apt to drop; stem short to medium; skin thin, tender, greenish-yellow overlaid with stripes of light and dark red; flesh yellowish, firm, crisp, juicy, sprightly sub-acid, very good to best. September to November. There are several types. One of the best is Banks. It is a Red Gravenstein, another is sold as Red Gravenstein.

Hagloe. Tree small, very slow grower, flat, spreading, rather dense; fruit medium to large; stem short to medium; skin tender, smooth, greenish yellow washed and mottled with pinkish-red, prevailing effect yellow; flesh white, moderately tender, sprightly sub-acid. August and September but will keep a long time without rotting.

Hibernal. One of the best Russian apples valuable for the upper Mississippi Valley and the Northwest and in the northern apple regions of Canada. Tree vigorous, very spreading, very hardy, productive; one of the best stocks for top-grafting; fruit large, roundish, oblate; skin thick, greenish yellow, a small amount of red on the sunny side; flesh acid, juicy, good for cooking. September to January.

Jefferis. Excellent for home use; ripens unevenly. Tree moderately vigorous, hardy, healthy, reliable bearer, biennial cropper; fruit medium size, yellow splashed with red; flesh tender, mild sub-acid, delicious. September to January.

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* Leading commercial varieties.

July (Fourth of July). Fruit resembles Tetofsky. Tree hardy, productive; fruit medium size, lacks uniformity, pale yellow, skin mottled or washed with red; fairly good flavor. July to September.

Lobo. A McIntosh seedling resembling McIntosh originated by Can. Exp. Farms, Ottawa, Canada, and very promising.

Longfield. A Russian variety, hardy, productive, recommended for home use and local and special markets; fruit below medium size; skin yellow, lightly blushed with red; pleasant flavor. A dessert apple, good for culinary use. Does not keep very well. September to October.

Lowland Raspberry. (Liveland). A Russian apple which ripens as early as Yellow Transparent. Tree very hardy, upright, productive; fruit medium to large, white splashed and striped with crimson; flesh white often stained with red, fine, very tender, mildly sub-acid, almost sweet.

Milton. A McIntosh seedling originated by Geneva (N.Y.) Agr. Exp. Station; ripens betwen Early McIntosh and McIntosh.

***McINTOSH.** A seedling of Fameuse and adapted to a wider range of territory. On account of its high quality, attractive appearance, bright, deep red color, good size, tender flesh, it has rapidly found favor in certain markets, especially for local markets, although if properly handled it may be exported and is appreciated in Glasgow, Scotland. It is quite susceptible to scab. The crop ripens unevenly, in some sections is apt to drop, two or three pickings are necessary. Usually needs a pollenizer.

Tree strong grower, more hardy than Fameuse, vigorous, healthy, comes into bearing rather early, reliable cropper, frequently biennial, sometimes annual; roundish or spreading, usually the center should be left in it and it should be encouraged to make an upright growth while young; fruit above medium to large, roundish to oblate; skin thin, tender, whitish-yellow or greenish, deeply blushed with bright red and some specimens almost purple, overspread with a thin lilac bloom; flesh white, sometimes veined with red, firm, crisp, tender, very juicy, sprightly sub-acid, becoming mild when nearly ripe; very good to best for dessert and esteemed for baking. September to January and later. McIntosh is being used as one of the parents, usually pistillate, for a group of new varieties.

McMahon. A pale yellow or almost white apple with a delicate pink blush, of Russian origin. Tree very hardy, medium, vigorous grower; flesh juicy, brisk sub-acid, fair to good, excellent for culinary use. October to February.

Maiden Blush. Grown in a limited way over the Central states and New York. Tree fine grower, hardy, long-lived, medium size, spreading, comes into bearing rather young, reliable cropper, bearing annual or biennial crops; fruit ripens irregularly and must be picked more than once; excellent culinary apple; skin lemon yellow with a blush. September to December.

Mother. A beautiful red apple resembling Esopus, highest dessert quality. Tree small to medium, moderate grower, subject to canker, biennial cropper bearing moderate crops, recommended for home use. September to January.

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* Leading commercial varieties.

***OLDENBURG**, (trade name Duchess). A culinary apple, one of the most valuable of the Russian apples, profitable commercially, used as a filler. The fruit must be handled quickly like peaches, and shipped under ice. Trees require good cultivation, careful spraying and frequently fertilization to secure the best commercial results. Tree hardy, a moderate or slow grower, of medium size, at first upright-spreading, later roundish, comes into bearing early; fruit medium size; skin thick, pale greenish-yellow covered with stripes of bright red or crimson; flesh yellow, rather firm, sprightly sub-acid, too acid for a good dessert apple. Some strains bear higher colored fruits than others. Red Oldenburg being one. July to September.

Patten, A seedling of Oldenburg, recommended for Minnesota, North Dakota and regions where hardiness is essential. Tree very hardy, productive; fruit large, green, sprightly sub-acid, culinary. October to January.

Primate. A dessert and culinary apple excellent for home use. Tree subject to canker, fairly productive; does well as a dwarf; fruit pale yellow, often slightly blushed. August and September.

Pumpkin Sweet. (Pound Sweet). Tree medium to large, upright-spreading, roundish, open, biennial bearer, fairly hardy, subject to winter injury, cankers; fruit large to very large, globular to roundish-conic; stem very short, stout; skin thin, tough, first green later yellow; flesh yellowish, firm, moderately crisp, juicy, decidedly sweet, esteemed for culinary use, especially baking. One of the best sweet apples of its season for canning, baking or stewing with quinces. Thrives best on well-fertilized sandy loams with a well-drained subsoil. October to January.

Red Astrachan. This beautiful early summer apple is well known, being grown over a relatively large area for home use and local market. Tree medium to large, upright-spreading to roundish; fruit medium not uniform; stem medium, rather slender; skin thin, pale yellow nearly or entirely overspread with light and dark red; flesh crisp, tender, juicy, good to very good. July to September.

Red June. Popular in the South and West. Tree moderate grower, reliable bearer, generally yields good crops. Crop ripens unevenly necessitating two or three pickings. Fruit small, deep red, tender, brisk subacid. July to October.

Ribston. (Ribston Pippin). Tree hardy, vigorous, healthy, long-lived, medium to large, upright-spreading; fruit medium or above; skin yellow or greenish-yellow covered with a dull red; flesh yellow, very crisp, sprightly sub-acid, very good. September to December. Fruit does not keep well. Sometimes planted in Nova Scotia for shipment to Great Britain.

Scarlet Pippin. (Crimson Beauty). One of the Fameuse group, firmer in flesh and slightly more acid than McIntosh. Does not equal Fameuse in quality. Tree strong, upright grower, productive in some sections. Season about the same as Wealthy. It is worthy of trial in regions that a moderately hardy apple is required, such as Fameuse.

* Leading commercial varieties.

Shiawassee. One of the Fameuse type, of good size, attractive appearance, dessert quality, flavor and aroma somewhat similar to McIntosh. Usually McIntosh is preferred to it. Tree very hardy, vigorous, upright-spreading, healthy, long-lived and bears annual and more often biennial crops. October to January.

Starr. Tree good grower, upright-spreading, comes into bearing early, often an annual bearer, is esteemed in New Jersey and Delaware; fruit large, green or yellow, very good in quality, dessert. August to September.

Stump. Beautiful apple resembling Chenango in appearance. Worthy of a place in the home orchard or for local market. Tree upright, compact, stocky grower, hardy, long-lived, bears biennial crops. September to October.

Summer Rambo. Tree upright-spreading, vigorous; fruit large to very large, oblate to roundish oblate; stem short to medium; skin thick, tough, greenish or clear bright yellow washed and mottled with pinkish red with bright crimson stripes; flesh yellowish-green, firm, coarse, very juicy, mildly sub-acid, good. An old variety which has not made much headway. It is grown from Pennsylvania southward and westward. Chiefly for home use. September to November.

Sweet Bough. A favorite in the home orchard, regarded as one of the best of the early summer apples. Tree moderately vigorous, bears rather young, generally long-lived; in some sections subject to cankers; fruit is highly regarded for culinary purposes and for dessert. August to September.

Tetofsky. A Russian apple. Tree very hardy, very upright, deep rooted, bears while young usually annual, sometimes biennial crops; fruit below medium size, yellow with crimson stripes, sprightly sub-acid, usually matures a little earlier than Yellow Transparent which is superior to it in size and dessert qualities. Suitable for regions where hardiness is essential. July to early September.

Titovka. Very good for culinary use. Tree vigorous, bears young, moderately productive. A highly regarded Russian variety. Sometimes planted in the Dakotas, Montana and Wyoming. Fruit yellow, usually covered with red. August to September.

***TWENTY OUNCE.** An important fall commercial apple in New York. Tree moderately vigorous, upright becoming roundish and dense, trunk and large limbs apt to be attacked by sunscald and cankers; as usually grown the tree is not as large as Baldwin and is usually planted closer. Does best on well-drained loams. Fruit very large, roundish or roundish-conic; stem short to medium; skin thick, tough, greenish becoming yellow mottled with red; flesh yellowish white, coarse, juicy, sub-acid; good for culinary use. Late September to December. Strains showing more red color occur, some are being propagated—Collamer, Hitchings, Anderson, etc.

***WEALTHY.** A leading commercial fall apple. Tree dwarfish to medium size, upright spreading or roundish, open and somewhat drooping; grows fairly rapidly while young, later it becomes a slow grower and needs regular and heavy pruning to maintain vigorous growth; fruit above medium to large, apt to get small on old trees unless thinned and cultivated; stem short to medium, rather slender, variable; skin thin, tough, greenish or pale yellow marked with stripes and splashes of red which become brilliant, sometimes covering the fruit; flesh whitish, sometimes stained with red, crisp, tender, very juicy, sub-acid, good to very good. Fruit should be placed in cold storage when picked or be precooled before shipment. Two or three pickings should be made; the fruit ripens unevenly. In some sections it is apt to drop. October to January.

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* Leading commercial varieties.

Williams. A beautiful bright red apple of agreeable flavor suitable for dessert and culinary purposes. A favorite in New England and Atlantic Coast states. Tree rather small, a slow grower, upright-spreading or roundish; annual or biennial bearer; fruit medium to large if thinned, oblong conic; stem medium to long; skin moderately thick, rather tender, pale yellow overlaid with deep red; flesh sometimes tinged with red, little coarse, tender, rather juicy, but becoming dry when over-ripe, mild sub-acid, good. The tree is a very slow grower in the nursery. Some recommend topworking on some other trunk as Tolman Sweet or Paragon. Needs two or three pickings. August and September.

***WOLF RIVER.** Resembles Alexander in size, form and color, but is more round and averages larger. It is largely superceding Alexander in the Western states. Tree large, moderately vigorous, quite spreading, open and inclined to droop, very hardy and usually a biennial cropper of moderate to good crops; fruit large, uniform; stem short to medium, rather thick; skin rather thick, greenish to bright yellow blushed with bright red and splashes and stripes of bright crimson; flesh slightly tinged with yellow, firm, moderately coarse, tender, juicy, sub-acid, fair to good. The fruit must be handled quickly, precooled or shipped under ice since it goes down quickly. Fruit may be harvested while green as soon as it has sufficient size to supply the baking trade. September to December.

Yellow Transparent. One of the most common of the early apples. Very good for culinary use and used for dessert. Tree medium size, moderately vigorous, upright becoming spreading or roundish, rather dense, subject to fire blight; fruit medium to above, roundish to roundish-conic; skin thin, tender, pale greenish-yellow to whitish-yellow; flesh white, fine grained, crisp, tender, juicy, sprightly sub-acid but not of high flavor, good. The fruit must be handled like peaches, shipped in packages holding not more than a bushel, be precooled and shipped under ice. Needs thinning to get size, except on young trees. Late July and August.

WINTER VARIETIES OF APPLES

Akin. Succeeds in the Middle West and South and adapted to warm soils. Tree upright, becomes somewhat spreading, dense, medium size, moderately vigorous; fruit medium to large, oblate; stem medium to long, slender; skin tough, smooth, attractive, highly blushed with bright deep-red; flesh whitish, very juicy, sub-acid, good to very good, for dessert. January to June.

***ARKANSAS.** (Mammoth Black Twig). A late-keeping, rather large, red-colored apple of good quality, adapted to the southern and southwestern apple-growing regions. Stocks in nurseries are badly mixed with Paragon. Is reported as a somewhat shy bearer in some places. Tree rather large, vigorous, upright-spreading rather open; fruit large to medium, uniform in size, roundish to conic; stem long to short, rather stout; skin nearly smooth, green, often becoming yellow, covered with a dull, deep red; flesh tinged with yellow, very firm, moderately juicy, subacid, good. December to May. Fruit very subject to scald.

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* Leading commercial varieties.

Arkansas Black. A dark red late-keeping apple adapted to parts of the South and Southwest is unproductive elsewhere and is distinct from above.

Bailey Sweet. Is of value for home use, a sweet red apple of very good quality for fall use. The fruit is apt to be scabby unless well sprayed. Tree lacks vigor, health and hardiness; slow grower; does not become very large. September to October.

***BALDWIN.** The leading variety in northeastern commercial orchards and a standard market apple for winter use. When well grown it is bright red, medium to large size, of firm texture and has a thick skin. It is well suited to parts of New England, New York, Michigan and parts of Southern Canada and Northern Ohio. South or north of these regions it does not reach its best. Tree large, vigorous, upright-spreading; is apt to become dense; fruit usually large, to somewhat above medium; generally uniform in size; stem medium to long; skin tough, smooth, light yellow or greenish with bright red coloring over it, so that the prevailing effect is bright red; flesh yellowish, firm, rather tender, juicy, good to very good. November to May. This is well adapted for general market, dessert and culinary use. It is an excellent pie apple.

Baxter. A large red apple somewhat resembling Tompkins King which does not rank high in quality, but which may be grown north of the Baldwin area, where it is a strong grower, hardy, productive and not subject to scab. November to January.

***BEN DAVIS.** Probably grown over a greater area than any other apple. It has been the leading commercial variety. It is preeminently successful through the Central states from Virginia to Arkansas. Usually needs a pollenizer. Tree medium size, growing rapidly while young, upright, becoming roundish later, rather spreading, not long-lived, subject to canker; fruit medium to large, roundish to conic or oblate in shape, excellent keeper and shipper; stem medium to long, slender; skin tough, waxy, bright, smooth, usually glossy greenish or yellow colored, with bright red splashed with dark carmine; flesh whitish, slightly tinged with yellow, firm, somewhat coarse, not very crisp, somewhat juicy, fair to good. January to June. A good cooking apple. Makes fairly good dried apples. Is suitable for export, but is losing ground on home markets.

Black Ben Davis. This variety is quite brilliant in color and attractive in appearance. Size and color being intermediate between Jonathan and Ben Davis. Quality similar to Ben Davis, and about the same season although the trees are somewhat more upright in growth and less willowy.

Black Gilliflower. A dessert and baking apple in demand in the Central South. Tree large, moderately vigorous, upright spreading somewhat open; fruit medium, seldom very large, uniform, ovate to oblong conic, ribbed; stem long to medium; skin tough, thick, smooth, yellowish or greenish-yellow, covered with red to purplish-red or almost black; flesh white or whitish-yellow, firm, rather coarse, apt to be somewhat dry, mild sub-acid, peculiar flavor. October to February.

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* Leading commercial varieties.

Boiken. A culinary apple, not desired on the market. Tree moderately vigorous, somewhat spreading, rather dense; fruit medium to large, ribbed, oblate, uneven; stem long to medium; skin tough, smooth, waxy, bright pale yellow frequently with pinkish to reddish blush; fruit attractive for a yellow apple; flesh white, firm, crisp, tender, very juicy, brisk sub-acid, not high in quality. November to May or later.

Canada Baldwin. A member of the Fameuse group, but a better keeper than Fameuse, and less attractive. Is suitable for a district requiring a hardy variety of the Fameuse type to extend the season of the latter.

Collins. (Champion). Suited to the Southwestern and Central states. Tree large, vigorous, tall-growing, upright, dense; fruit large to above medium; stem medium to short; skin thick, tough, bright dark-red, when well colored; flesh nearly white, very firm, rather coarse, crisp, moderately juicy, sprightly sub-acid, fair to good. January to June.

Cooper Market. Tree a hardy, reliable bearer, but is slow in coming into bearing; fruit bright-red color, attractive, not of high quality, apt to be small, hangs well, keeps well. December to May.

Cortland. A cross of McIntosh and Ben Davis which resembles McIntosh but is better, larger, brighter in color, ripens later and keeps longer. Originated by New York (Geneva) Agricultural Experiment Station.

Deacon Jones. Fine grower, thrifty, bears annually, productive; fruit large, uniform, hangs well; not very high in quality, color dull-red. November to March.

***DELICIOUS.** This apple has received more advertising than any other variety in a like period of time. It is growing in all districts of the United States although introduced as recently as 1895. Necessarily, an apple so recently introduced is still on probation in many regions but as a box apple for the Western states it is one of the highest priced market apples. The variety was originally distributed under the name Hawkeye, being discovered in Iowa in 1881. The tree is more hardy than Baldwin and is quite hardy, large, vigorous, spreading, productive; fruit medium to large, roundish conic to oblong conic, ribbed; stem long, medium thick; skin very thick, tough, smooth, light-yellow, nearly to almost entirely covered with dark attractive red, splashed and mottled with carmine; flesh yellowish, firm, little coarse, tender, juicy, pleasant sub-acid, good to very good. December to February. On its own roots it appears to be resistant to root-rot. For regions where it lacks size and color, try its seedlings—Medina, Delicious 1940, from Geneva (N. Y.) Agr. Exp. Sta.

Domine. Resembles Rambo, but is a better keeper. Used for dessert; not commercial. November to March.

***ESOPUS SPITZENBURG**, trade name Spitzenburg. The standard of excellence for apples of the Baldwin class to which it belongs. Choice dessert apple, valuable for canning or culinary use. Ships well, holds well in storage, well suited for marketing in boxes and brings good prices. In season with Baldwin. Fruits susceptible to scab. Tree often injured

* Leading commercial varieties.

by canker, frequently lacks vigor, needs fertile soil well supplied with humus and moisture. It thrives in the irrigated regions of the Western states, but is declining in the East and West, being a shy bearer. It is one of our leading commercial apples owing to its position in the West. Tree generally slow grower, rather open and spreading, moderately upright; fruit medium to large; stem medium; skin tough, sometimes waxy, deep, rich-yellow almost entirely covered with bright-red, striped with darker red; flesh somewhat yellow, firm, crisp, rather tender, juicy, sprightly sub-acid, very good to best. November to May.

Fallawater. Tree a regular bearer, producing biennial crops; fruit large, drops badly. Is not being planted.

Gano. (Black Ben Davis). Tree resembles Ben Davis. Fruit usually solid, deep-red color, resembling Jonathan, good keeper. Tree comes into bearing young, is an excellent cropper, regular, abundant bearer; fruit perhaps somewhat superior to Ben Davis in quality. Some regard its storage season as slightly less than Ben Davis.

Golden Delicious. A yellow dessert apple originated about thirty-five years ago and recently introduced as one of the most desirable cosmopolitan yellow dessert apples; on trial.

Golden Russet. A small dessert apple. Tree medium to large, moderately vigorous, upright, roundish, becoming spreading, apt to grow dense, hardy, biennial bearer; fruit medium or below in size varying from oblate to conic; skin thick, tender, covered with green or yellowish-russet; flesh yellowish, fine-grained, tender, juicy, rich, sub-acid, very good. December to May.

***GREEN NEWTOWN**, Yellow Newtown (Albemarle Pippin, Newtown Pippin). Occupies a unique position in Virginia where it is grown as the Albemarle Pippin; in Central California and in irrigated regions in Oregon and Washington and in the Hudson Valley. Is quite susceptible to scab and unless on fertile soils given good cultivation and insects and diseases are kept well under control, there is usually a high percentage of ill-shapen, low grade fruit. Under favorable conditions, the fruit is of good size, and variable in form and color. It keeps well and is used for export. Tree moderate grower, erect, becoming spreading or roundish and rather dense; slow in coming into bearing; fruit medium to large, variable, usually roundish oblate, sometimes quite angular; stem medium to short; skin rather tough, grass green when harvested later turning to yellow; shows brownish or brownish-pink color near the base and white lenticals; flesh yellowish, firm, crisp, tender, sprightly aromatic, sub-acid flavor, best quality, dessert. February to May.

***GRIMES GOLDEN**, (Grimes). A golden-yellow attractive apple excellent for dessert or culinary uses; it is not a good keeper, is apt to scald in storage, and must be put on the market during late fall and early winter. It is grown from Pennsylvania southward. Tree moderately vigorous, upright-spreading or roundish; apt to succumb to canker; subject to fire blight. Collar blight destroys many trees about the time they come into profitable bearing, hence some advise its being topworked on Paragon or Tolman Sweet so that the trunk will not be in contact with the ground. Fruit medium to large, roundish, oblate; stem short to medium; skin tough, somewhat rough, clear deep yellow; flesh yellow, very firm, tender, crisp, moderately juicy, sub-acid, rich; very good to best. November to end of January.

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* Leading commercial varieties.

Hubbardston. A dessert apple grown in New England and New York, but not highly esteemed on the markets. Tree vigorous, somewhat large, erect to roundish, apt to grow dense, subject to canker, biennial bearer; fruit medium to large, sometimes very large, stem short to very short; skin sometimes smooth, but generally rough, showing flecks and grains of russet, yellowish or greenish with red, which may be bright to deep carmine; flesh whitish, tinged with yellow, moderately firm, somewhat fine-grained, crisp and juicy at first, but later becoming mildly sub-acid, very good. October to January.

***INGRAM.** Is of exceptional promise for the Ozark region, where it has been chiefly planted for commercial use. It blooms late in the season. which enables it to avoid some of the late spring frosts. In quality it ranks about with York Imperial; in flavor it is much like Ralls, but less juicy. Tree vigorous, upright or roundish and rather dense; fruit medium, sometimes large, roundish, conic to roundish oblong, symmetrical; stem rather short, variable from thick to somewhat slender; skin thick and tough, smooth, bright greenish-yellow or pale-yellow, washed with shades of red, highly colored specimens are nearly overspread with dark-red; flesh somewhat tinged with yellow, firm, hard, crisp, tender, juicy, mildly sub-acid, of good flavor. February to June or later.

Jacobs Sweet. A green or yellowish sweet apple, resembling Sweet Bough; one of the best sweet apples of the season for baking. Fruit very tender, liable to crack in spots, rots on the tree, also in storage, a very unreliable keeper. Its commercial limit varies from October to April. For home use.

Jewett Red (Nodhead). A very good dessert apple for early winter use, beautiful dark-red color, well adapted to New England, particularly Maine and Northern New Hampshire, where it is grown commercially. Tree slow grower, medium height, spreading or roundish, somewhat open, bears early, needs good care; fruit medium; stem short; flesh yellowish, tender, juicy, sub-acid to nearly sweet. Good to very good. October to February.

***JONATHAN.** A brilliant red, of excellent quality, high flavor, suitable for dessert or culinary use. It excels its parent, Esopus, in hardiness, productiveness, health, vigor, and is adapted to a wide range of territory, being common through all the Central states and held in high esteem in Oregon and Washington where it has probably been over-planted. If grown north of the Central states it needs rich soil and extra care, otherwise it does not make sufficient size. Desirable for the fancy trade at the holiday seasons, it is not usually kept later than January or February since the fruit develops dark spots on the skin in common storage. In cold storage it may be kept until March. Under favorable conditions, the tree is a reliable cropper, usually biennial, sometimes annual, comes into bearing young; fruit hangs well. Tree medium size, roundish or spreading, somewhat drooping, rather dense; fruit medium; stem medium long, rather slender; skin thin, tough, smooth, pale bright-yellow, overlain with red and carmine, so that the fruit when ripe is almost completely covered with red to purplish; flesh whitish or somewhat yellowish, tender, juicy, sprightly sub-acid, very good to best. November to February.

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* Leading commercial varieties.

King David. Discovered in Arkansas in 1893, supposed to be a cross between Jonathan and Arkansas Black. Must be picked as soon as colored. Tree vigorous, healthy, hardy, productive; fruit medium size, roundish oblate to oblate conic, apt to rot at the core when ripe; stem medium, slender; skin pale greenish yellow, almost entirely overspread with very attractive deep dark-red, tinged with scarlet; flesh distinctly yellow, firm crisp, juicy, brisk, sub-acid, spicy aroma, good to very good. November to February.

Kinnaird. This dark red winter apple belongs to the Winesap class. When well grown, the fruit is of good size, very good quality, attractive in appearance. Tree comes into bearing rather young, yields moderate crops biennially. Origin Tennessee, and is planted to some extent in the Southern states.

Lady. This strikingly beautiful little apple is used for decorative purposes and for dessert. Tree usually moderately vigorous at first, later becoming a slow grower, medium size, in fact dwarfish, does very well on dwarf roots; fruit small to very small, oblate to conic; stem medium slender; skin tough, smooth, with deep-red blush against a clear pale-yellow or whitish ground; flesh white, firm, crisp, juicy, mildly sub-acid, good to very good for dessert. December to May.

Lady Sweet. A desirable sweet apple, which stores well and ships well, and frequently sells fairly well; desirable for the home orchard. Tree comes into bearing young, a regular bearer, a good cropper, the fruit being useful for dessert or culinary purposes; color yellow with red stripes or solid. Tree is apt to overbear. November to May.

Limbertwig. A medium-sized, deep-red, late-keeping apples, rather popular in the South. Tree vigorous, productive. January to April.

Macoun. A very late McIntosh, follows Cortland. One of the new varieties originated by Geneva (N. Y.) Agr. Exp. Station.

Malinda. This variety does well in Iowa and Minnesota. Even there it is advised to topwork it on Hibernal. Tree slender, straggling grower in the nursery; fruit medium to large, sharply conical; stem short; skin smooth, rich-yellow with dull-red blush; flesh yellowish-white, juicy, mild sub-acid. Late winter.

Mann. A hard, green, late-keeping apple sometimes used as a substitute for Rhode Island Greening late in the season after the Rhode Island Greening is off the market. It is inferior in flavor to the Greening but the tree is superior to it in hardiness, is usually a reliable cropper, yielding biennial crops of uniform fruits which store well, is apt to overload. It is not being planted extensively and is not wanted on the markets.

Melon. One of the best dessert apples of its season, being bright-red striped on a yellowish ground; crisp, tender, delicious, well adapted for local market and fancy trade. Fruit is quite subject to attacks of apple maggot. Foliage and fruit quite subject to scab. Tree apt to be injured by cankers in the limbs and trunk. It is an unsatisfactory grower in the nursery and some advise topworking it. Tree apt to make a dense top, requires care in pruning. October to middle winter.

Milden, (Milding). Highly esteemed in portions of New England where it is planted for home and commercial use. Tree good grower, hardy, healthy, bears while young, reliable cropper, yielding biennial crops; fruit is apt to drop, usually uniform in size and shows few culls; color bright-red over pale-yellow or whitish; quality and appearance good. November to February.

Milwaukee. Tree very hardy, healthy, bears early, usually annual crops and is well adapted to regions where hardiness is a prime requisite; fruit bright clear-yellow, marked with bright-red, somewhat resembles Oldenburg; briskly sub-acid, suitable for culinary use and market rather than dessert. October to February.

Minkler. One of the popular varieties in the Middle West. Tree large, strong grower, reliable cropper, very spreading becoming drooping in old trees; fruit medium to above, uniform; stem medium to short; skin thin, tough, greenish-yellow changing to pale-yellow, almost entirely overspread with light, pinkish-red which may be striped and splashed with dark, dull-carmine; flesh strongly tinged with yellow or greenish, very firm, somewhat coarse, not very crisp, mildly sub-acid, fair to good. November to May.

***MISSOURI PIPPIN.** One of the well-known market apples of the Middle West where the tree is apt to be short-lived; it comes into bearing early and is a reliable and heavy cropper; moderately vigorous, upright, becoming roundish or spreading; fruit medium size, roundish sometimes conic, apt to be too small on old trees; skin thick, tough, rather glossy, thinly coated with graying bloom, pale-green or yellow overspread with bright-red striped with purplish-red, so that highly colored specimens are almost solid-red; flesh tinged with yellow, firm, not very tender, not very juicy, briskly sub-acid, fair to good in quality, apt to scald in storage. October to April.

Monmouth. (Red Cheeked Pippin). Resembles Rhode Island Greening but not equal in quality, often carries a distinct blush. It is sometimes stored late in the season and does not appear to be subject to scald. Tree hardy, long-lived, comes into bearing moderately young, frequently a considerable amount of the fruit is low grade. It is not being recommended for general planting but in favorable localities it is proving profitable. These are scattered from New Jersey westward to the Middle West, and it has been planted in the Northwest in small amounts. November to February.

Nero. Regarded with favor in Central and Southern New Jersey. The fruit is of the Minkler type, medium size, attractive red color, firm, with tough skin, handles well, keeps well, but is inclined to scald after midwinter unless fully colored.

Nickajack. A well-known variety in various parts of the South and Southwest. Practically reproduces itself from seed in favored localities. Tree large, vigorous, strong grower, upright spreading, very productive; fruit medium to large; stem usually short and thick; skin thick, tough, yellow or greenish covered with orange-red or red splashed and streaked with carmine; flesh yellowish, very firm, mildly sub-acid, not high in flavor or quality. December to May.

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* Leading commercial varieties.

*__NORTHERN SPY__ (Spy). Well adapted for general, local or fancy trade. Possessing size, beauty, flavor and high quality, it usually sells above average prices. Tree very hardy, grows large, up to 50 feet diameter, develops a strong root system, upright, later becoming somewhat dense, roundish with willowy branches, somewhat inclined to droop. Top tends to become dense and needs regular pruning, usually of the small twigs to admit sunlight and air. It is apt to develop too many limbs and laterals which may shade the center of the tree. The wood is very straight grained and the tree is liable to split, hence the angle which the branches make should not be too acute and they should not start opposite each other but be well spaced on the main stem at least a foot apart. Takes seven to ten years to come into bearing, blooms late, may need a pollenizer. Fruit large; skin thin, tender, smooth, clear pale-yellow ground covered with pinkish-red or splashed with carmine, the prevailing effect is striped-red; flesh yellowish, rather firm, very tender, crisp, very juicy, sprightly sub-acid, very good to best. Must be handled with great care. November to March. A solid-red skinned variant is now on sale as Red Spy.

Northwestern Greening. Promising for sections requiring a hardy tree although it is grown in regions such as New York where other varieties would succeed. Tree vigorous, apt to become dense, upright becoming quite round, spreading and inclined to droop, biennial cropper; fruit uniform, medium to large or very large, variable, usually roundish; stem medium to short; skin smooth, somewhat waxy, clear pale-yellow or greenish, sometimes faintly blushed; flesh tinged with yellow, medium texture, juicy, mildly sub-acid, fair to good. A good culinary apple, it may be stored until June.

Oliver (Senator). Originated in Northwest Arkansas. Tree medium size, roundish or somewhat spreading with an open top, annual bearer; fruit large or above medium, roundish or oblate; stem short to moderately long; skin moderately thin, tough, waxy, green or bright-yellow mottled striped with red or splashed with bright deep-red and purplish-carmine; flesh yellowish-white rather tender, sprightly sub-acid later turning sweet, very good. September to April.

Olympia. Origin Olympia, Washington. Said to be a more highly colored Baldwin.

Ontario. A cross between Northern Spy and Wagener. When highly colored it is faintly pink striped with red or carmine. It is less productive than Wagener and longer lived; is doing well in parts of Canada, is worthy of trial where Northern Spy succeeds. November to March.

Opalescent. In the nursery and in the orchard the tree resembles Twenty Ounce, of which it may be a bud sport. Collamer, Hitchings, Anderson and others are bud sports of Twenty Ounce. It is subject to fire blight, is fruiting from Maine to Delaware. Fruit large to very large, roundish conic; stem short to medium; skin moderately thick, glossy, takes a brilliant polish, pale-yellow nearly and frequently entirely covered with dark deep-red, in some cases almost black-red; flesh distinctly tinged with yellow, rather firm, somewhat coarse, mildly sub-acid, fair to good. November to February. This apple is so attractive where it is being grown in New England that it is easily sold although its quality is poor.

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* Leading commercial varieties.

Paragon. Is adapted to the South Central states, it belongs to the Winesap group; does very well on sandy land in central and southern New Jersey and south and westward. Tree moderately vigorous, roundish to spreading, inclined to droop, rather dense; fruit above medium, roundish or sometimes oblate, slightly conic; stem medium; skin tough, smooth, green or yellowish, largely covered with dull, deep-red, the prevailing effect dark-red; flesh greenish or tinged with yellow, firm, somewhat coarse, juicy, mildly sub-acid, good to very good. January to May.

Peck Pleasant. Belongs to the same group as Green Newtown, Rhode Island Greening and is an excellent home use dessert apple. Tree subject to root rots and canker, is not long-lived, is often a shy bearer; fruit usually green to yellow with pink blush, scalds badly in storage. October to March.

Pewaukee. A cross between Oldenburg and Northern Spy, not as hardy as Wealthy. Tree strong grower, usually healthy but in some sections it suffers from canker, bears early, producing biennial, sometimes annual and heavy crops. It is not a profitable variety because the fruit is deficient in color and quality. Fruit above medium to large, often poorly colored, being green striped with dull-red, overspread with heavy bluish bloom giving a dull effect, fair to good in quality. Its principal use is for culinary purposes. November to April.

Pomme Grise. A little Russet apple of value for home use because of its excellent dessert quality. Develops high flavor in the St. Lawrence Valley. Tree hardy, healthy, moderately long-lived.

RALLS (Genet, Geneton, etc.) A well-known southern variety perhaps better known as Geneton. It grows throughout the whole of the Ben Davis apple region and produces fruit held in esteem both for use at home and the markets. Young trees are apt to produce annual crops, later they overload and become biennial bearers. Trees bloom late, hence may set a crop when those which bloomed earlier failed. Tree medium in size, upright becoming spreading, inclined to droop; fruit medium to above, roundish oblate inclined to conic; skin smooth, yellow or greenish blushed and mottled with pinkish-red which may be striped with dull-carmine covered by a light bloom which gives the fruit a rather dull appearance; flesh whitish, firm, crisp, juicy, sub-acid, very good for dessert. December to May.

Rambo. When well grown is an apple of excellent quality. The prevailing color is bright-red which is distributed on a yellow ground. The tree is less hardy than some of the standard varieties and is sometimes injured by the winter. The wood is rather brittle and often breaks under heavy crops. It seems to do best on light, rich soils with well drained sub-soils and has been cultivated through Delaware, New Jersey and Pennsylvania. If carried north it becomes too small. Flesh yellowish-white, crisp, tender, mildly sub-acid, good to very good, useful for dessert. October to February.

Red Canada (Steele's Red). A dessert apple, variable in quality. When grown on gravelly and sandy soil in a favorable season, in color, quality, flavor, it equals Esopus, while on heavy clay soils it may be inferior to Baldwin. Fruit is apt to lose its flavor after mid-winter in storage. Tree medium to large, upright to roundish, rather dense, lacks vigor and hardiness, in some cases it is an annual bearer and in others it is unreliable; fruit medium to large, roundish, inclined to conic; stem medium to rather slender; skin tough, light-yellow or green covered by deep-red blush; flesh whitish with yellow or greenish tinge, firm, crisp, tender, rich, agreeable, sub-acid becoming milder as it matures; good to best. November to March.

***RHODE ISLAND GREENING.** Trade name Greening. One of tho best cooking apples grown and decidedly superior to Baldwin for all culinary purposes, also very good for dessert. Trees come into bearing early and are usually biennial bearers; usually need a pollenizer, in some sections they bear alternately a heavy crop and light crop. Tree large to above, strong, vigorous grower, widespreading, somewhat drooping, rather dense; needs careful pruning, not too much at one time; fruit large to very large, uniform, roundish to roundish oblate, sometimes slightly conic; stem medium; skin moderately thick, tough, smooth, waxy, grass-green to somewhat yellow sometimes with a brownish or bright-red blush; flesh yellowish, firm, fine-grained, crisp, tender, juicy, rich, sprightly sub-acid, very good in quality. Season October to March depending somewhat on where the fruit is grown; apples grown in Vermont where there is a large amount of sunshine, may have a season of February as the limit, while those in Western New York, grown on heavy land, may keep until April or longer. Is apt to scald in storage unless oiled wraps are used.

***ROME BEAUTY.** (Rome). Is well adapted to parts of the Northwest and in the East to the area south of the Baldwin territory and yet it is grown into the Baldwin area on the lighter soils. The tree comes into bearing at an early age and is frequently nearly annual in bearing. In Ohio and New Jersey the tree seems to do better when planted upon sandy, gravelly soils and bottom lands than it does on heavy clays. The tree may need thinning. It is somewhat subject to attacks of scab and to powdery mildew; a moderate grower in the nursery but may attain good to medium size in the orchard; upright, later becoming roundish and may be spreading and drooping. Like the Northern Spy it may need annual pruning of the small limbs, two twigs of equal vigor are apt to form at one point thus constituting crotches. One should be removed. Fruit medium to very large, uniform, roundish to roundish conic; stem long, slender, the fruit hangs well; may be left quite late; skin thick, tough, smooth, yellow or greenish, more or less mottled or striped with bright-red; flesh firm, a little coarse, yellowish-white, crisp, juicy, agreeable, mild sub-acid, good but not of highest quality. It has a good standing in the markets and sells readily if of large size for baking. November to May. Sports bearing fruits solid-red in color are in cultivation as Red Rome.

Roxbury. Probably the most popular of our russet apples although frequently it will not make as much money on the market as the Golden Russet. A good cropper, useful for export, but the advent of cold storage has reduced the demand. Few are planted except in Nova Scotia. The Roxbury Russet needs fairly rich soils, well supplied with moisture; if all conditions are not suitable it is apt to be but a moderate cropper. Tree medium to large, sometimes quite vigorous, roundish spreading or flat; fruit above medium to nearly large, variable in size and shape, oblate to oblate conic, frequently elliptical; stem short to medium; skin tough or moderately tender sometimes almost smooth, greenish to yellowish-brown russet; flesh tinged with yellow or greenish, firm, somewhat coarse, moderately tender, juicy, sprightly sub-acid, good to very good. December to June.

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* Leading commercial varieties.

Comparing the Roxbury with the Golden Russet, the Roxbury tree is somewhat larger, usually more spreading, generally more productive. The fruit of Roxbury is larger and the stem is often tinged on one side with red. In the case of the Golden Russet the stem is shorter and it is not tinged with red. The flesh of the Golden Russet is more sprightly sub-acid, finer grained, richer flavored.

Scott Winter. Tree very hardy, healthy, comes into bearing early, a reliable cropper, should be given cultivation and be manured, otherwise the fruit is apt to be too small; color red to dark-red on a yellow ground; suitable for culinary purposes, may be kept in ordinary storage from December to May.

Smith Cider. Grown from New Jersey westward through Southwest Ohio and in Indiana. It is not high in quality, is used for culinary purposes and market. Tree good grower, comes into bearing young, usually productive; fruit a handsome red color on a yellow ground. It is not being extensively grown. November to March.

Smokehouse. A very pleasant flavored dessert apple, lacking in acidity for culinary uses; is grown in New Jersey and Pennsylvania. Fruit lacks character, being neither distinctly yellow nor red. Tree vigorous, hardy, healthy and usually bears biennial crops, comes into bearing early; both fruit and foliage are subject to scab; the tree tends to form a dense head, requires careful pruning to keep it open enough to get sufficient color on the fruit. Its cultivation is not extending. October to March.

Stark. Grown through the region where the Baldwin succeeds and both north, south and west of same and its planting is slightly increasing over that territory. Tree thrifty, hardy, reliable cropper and is generally quite productive; fruit large, smooth, uniform and keeps well; its chief fault is that it is often dull in color, having very little red, whereas when well grown it is nearly covered with red and when mature the yellow tends to show through; it has a thick skin, mild flavor, medium quality, suitable for baking and evaporating. It is used for export trade to some extent. January to May.

***STAYMAN.** Grows well in Southern New Jersey, Delaware, Maryland, Pennsylvania and Virginia and in other states adjacent to this area. It is better adapted to this locality than the region north. It is grown in the Northwest. Tree vigorous, spreading, somewhat open; fruit medium to large, uniform in size; stem medium to short; skin smooth, rather thick, tough, green, becoming yellowish, often nearly covered with rather dull-mixed red or distinct stripes of carmine; flesh tinged with yellow or slightly greenish, firm, tender, juicy to very juicy, sprightly pleasant sub-acid, good to very good. December to March.

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* Leading commercial varieties.

Sutton. An excellent dessert apple of mild flavor. In color, texture and flavor the fruit is intermediate between Hubbardston and Baldwin. Tree vigorous, upright spreading, eventually becoming roundish; it becomes quite dense and is difficult to prune. The variety is not making very much progress commercially.

Tioga. A late-keeping yellow apple which retains its flavor late in the season. A cross between Sutton and Northern Spy from Geneva (New York) Agricultural Experiment Station.

Tolman Sweet. (Tolman). Grown from Northern New York and New England and parts of Canada into the prairie region of the Middle West. The tree has made an enviable reputation as one of the hardiest of the New England varieties. For this reason it is often used as stock upon which to top-graft less hardy kinds. Tree moderately vigorous, upright, very spreading, drooping, open; fruit below medium size to large, usually uniform in size and shape, nearly globular to roundish conic; stem medium to rather long, slender; skin tough, pale yellow and it may be slightly roughened; flesh white, firm, rather hard, dry to moderately juicy, sweet, good to very good. Highly esteemed for baking. Sold to limited extent in special markets. It is not being extensively planted. November to April.

Tompkins King. Common trade name, King. Tree vigorous, spreading open; fruit large to very large, uniform in shape and size, roundish to somewhat oblate, sometimes conic; stem short to rather long; skin smooth or somewhat roughened, pine yellow mottled and washed with mottled red shading to deep-red and bright-carmine, prevailing color red over yellow; flesh yellowish, somewhat coarse, tender, juicy, sub-acid, very good to best. Late September to February. This fruit is very desirable for home use during October to Christmas. If the tree was more productive and less subject to collar-rot and certain other defects, it would be much more extensively planted. It requires fertile, well-drained soils. The trees are short-lived. Topworking on Tolman Sweet or some other hardy stock is advised. The fruit is easily blown off by winds when ripe.

Wagener. When well grown an apple of superior quality. It has fine texture, fine flavor and is excellent for dessert or culinary use. Easily injured by heat if the fruit is allowed to stand around after it is harvested, apt to scald quickly and must be hurried from the tree into storage. Trees are apt to overbear so that much of the fruit is undersized, and it is apt to drop. Tree weak grower; fruit medium to rather large, oblate to roundish oblate; stem short to moderately long; skin thin, tough, smooth, bright pinkish-red, striped with bright-carmine, prevailing color bright, light-red; flesh whitish slightly tinged with yellow, rather fine grained, crisp, juicy sub-acid, very good to best. October to February.

Walbridge. Planted to a considerable extent in Wisconsin, Iowa and adjacent portions of the Mississippi Valley. Tree medium in size, hardy, moderately vigorous, upright-spreading or roundish, open, comes into bearing early, biennial cropper; fruit usually medium or below, frequently mis-shapen, lacking size and often unmerchantable, roundish conic;

stem short to medium; skin moderately thick, tough, green becoming clear pale yellow or whitish washed with red, which is mottled and striped with bright carmine, overspread with thin bloom; flesh whitish tinged with yellow, firm, little coarse, moderately tender, sprightly mild sub-acid. Fair to good. November to March or April.

Westfield (Seek-no-further). An old favorite dessert apple of little value for cooking. Demand limited. Fruits lack color if grown on heavy or cold soils, do well on well-drained, rich, gravelly or sandy loam. Tree medium to large, spreading, roundish; fruit medium size to large; stem medium to long, rather slender; skin tough, smooth, greenish or deep-yellow, splashed with rather dull-red, overspread with thin bloom; flesh tinged with pale-yellow, firm, little coarse, juicy, mild sub-acid, rich. Very good to best. November to March.

White Pearmain. (Winter Pearmain). A favorite dessert apple in the Middle West from Ohio to Kansas. Also grown in parts of the Northwest under irrigation, in Arizona and other states. Tree vigorous, spreading; fruit below medium to nearly large, uniform in size and shape, roundish ovate; stem medium to long; skin tough, smooth, somewhat waxy, pale-yellow, slightly tinged with darker-yellow; flesh firm, crisp, tender, juicy, mild sub-acid. Very good to best. December to March.

White Pippin. The general appearance is of a medium to large yellow apple. Somewhat resembles the Yellow Newtown, but it lacks the spicy flavor of that apple. It is, however, more easily grown, is esteemed in New Jersey, Ohio, and parts of the Middle West; is not being extensively planted. Tree large, vigorous, upright-spreading to roundish, rather dense, bears early, annual or biennial crops; fruit medium to large, often rather large, roundish or roundish oblate, inclined to conic; stem short; skin pale-yellow or greenish; flesh tinged with yellow, firm, tender, crisp, juicy, sprightly sub-acid; good to very good. November to May.

Willow Twig. Southern or semi-southern variety, chiefly cultivated in the central portion of the Mississippi Valley. Trees make poor growth in the nursery but in the orchard is a strong grower, an early and regular bearer, upright-spreading, branches drooping on bearing trees; fruit large to medium, uniform, firm, roundish, inclined to conic, keeps well; stem short; skin smooth, pale yellowish-green, blushed with red, striped and splashed with deeper red, prevailing color red, usually rather dull; flesh yellowish or greenish, very firm, coarse, moderately tender, juicy, sprightly, fair to good. Frequently sells at high prices late in the season.

***WINESAP.** One of the oldest and most popular apples in America. It is more generally listed than any other. It is grown from Delaware, Maryland, Virginia, westward to the Pacific coast. It has given rise to many varieties of value as Arkansas, Arkansas Black, Paragon, Stayman. Tree not a rank grower, usually comes into bearing early, a fairly regular cropper, does not succeed on heavy clay soils, or on soils which contain too much moisture, does best on light, rich deep soils. In some sections, the trees are apt to be short-lived. Unless carefully handled the fruit is apt to grow too small as the trees get older. The fruit is an excellent shipper, stands up well in the fall enduring considerable heat at harvest time, is a good storage apple, but if not well colored it may show scald. Tree medium size, vigorous, roundish-spreading, rather straggling and open; fruit medium size, uniform in size and shape, usually conical; stem medium to short, rather slender; skin medium tough, smooth, glossy bright deep-red, striped and blotched with very dark, purplish-red, with yellow ground; flesh tinged with yellow, sometimes red; very firm, rather coarse, juicy, sprightly sub-acid. Good to very good. January to June.

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* Leading commercial varieties.

Winter Banana, Banana. A dessert apple, too mild for culinary use. Tree medium size, vigorous, rather flat, spreading, somewhat inclined to droop, open, an early and usually annual bearer, it is important that it be trained with a leader, otherwise it becomes flat-topped; fruit nearly large to large, variable in size and shape, usually roundish-conic, sometimes oblate or flat; stem short to moderately long; skin smooth, moderately thick, tough, waxy and pale-yellow with pinkish-red blush; flesh whitish, tinged with pale-yellow, moderately firm, somewhat crisp, tender, juicy, mildly sub-acid, good to very good. November to March.

Yellow Bellflower. (Bellflower, Bishop Pippin of Nova Scotia.) Found in many old orchards of the Northeastern United States. It was extensively planted in Nova Scotia and Central California as a culinary and sub-acid dessert apple. It is decidely attractive for a yellow apple, is subject to scab, shows bruises readily, does not withstand heat, should be put into storage promptly. Tree medium to large, vigorous, upright-spreading, the branches drooping, hardy, needs warm well-drained soils; fruit small to very large, variable in size, roundish oblate, frequently ovate or oblong conic, ribbed; stem medium to rather long; skin smooth, bright lemon-yellow, sometimes with a pinkish blush; flesh whitish, tinged with pale-yellow, firm, crisp, rather tender, juicy. December to April.

***YORK IMPERIAL,** trade name York. An important commercial apple in the middle Atlantic states and westward to Missouri and Kansas. The tree prefers rather heavy soils, does not do well on those which are thin and leechy, is adapted to the limestone soils in the Piedmont plateau, throughout West Virginia, southern Pennsylvania, western Maryland and northern Virginia. The disintegrated limestone forms a shaly or soapstone soil which this variety thrives in. It does well on the Porter loam. Tree is usually a thrifty and vigorous grower and bears annual or biennial crops, upright-spreading or roundish, rather dense; fruit medium to large, grows small as trees grow older, roundish oblate, usually lopsided; stem short; skin tough, bright, smooth, green or yellow with moderately light-red or pinkish-red coloring; flesh yellow, firm, crisp, moderately tender, moderately juicy, sprightly sub-acid later becoming mildly sub-acid; good to very good. December to February. The fruit stands heat very well before going into storage, but it often scalds badly and is apt to deteriorate quickly. Oiled wraps and shredded oiled paper in the barrel reduces scald and extends storage life materially.

CRABAPPLES

Excelsior. One of the largest, equalling a medium-sized apple. Tree large, somewhat flat, spreading, rather dense; a strong grower, hardy, healthy, comes into bearing early, biennial bearer; fruit very large for a crab, roundish to roundish oblate; stem rather long and slender; skin smooth, yellow splashed with red over much of its surface; flesh whitish, firm, somewhat coarse, juicy, sub-acid, good to very good. Used for dessert and culinary purposes. September.

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* Leading commercial varieties.

Florence. Tree moderately vigorous, upright-spreading, later inclined to droop, early bearer, reliable cropper; fruit medium size; stem very long, slender; skin moderately thin, somewhat tough, yellowish-white generally overspread with brilliant pinkish-red with a faint bloom; flesh tinged with yellow, coarse, rather tender, juicy, brisk sub-acid, somewhat astringent, good: late August to early September. It is not superior to Martha in quality but is more beautiful.

Gibb. A hardy crab, may be grown as far north as Montana. Tree slow, spreading grower; fruit large, yellow blushed with deep, dull-red; thinner skinned and less astringent than Hyslop, yellow flesh; highly esteemed for canning. Late September.

Hyslop. A well-known tree, vigorous, upright-spreading, rather open, good grower, very hardy, reliable cropper, sometimes annually, useful for home and market; fruit large, brilliant dark-red or purplish overspread with thick blue bloom and borne in clusters; flesh yellow, very firm, first juicy later becoming dry and mealy, sub-acid, astringent. September and October.

Large Red Siberian. Fruit medium size but smaller than Transcendent or Hyslop. Tree very hardy, healthy, reliable cropper, bearing biennial sometimes annual crops. September and October. Larger and more handsome varieties can be secured.

Large Yellow Siberian. Fruit medium to large, similar in size to Large Red Siberian, is being replaced by larger varieties.

Martha. Tree hardy, medium size, spreading, open, somewhat inclined to droop, early bearer; regular cropper; fruit rather small, roundish or oblate; stem long, slender; skin moderately thin, tough, pale-yellow almost entirely covered by light bright-red, overspread with bluish bloom; flesh yellowish, firm, somewhat coarse, juicy, brisk sub-acid, good to very good. One of the best of its class. September to November.

Soulard. Useful where hardiness is a prime requisite. Tree strong grower in the nursery, apt to overload and make slow growth later. A native crab. Many of the Russian types are superior to it.

Transcendent. One of the most popular in the East. Tree good grower, large, very spreading, hardy, usually quite productive, generally an annual bearer; fruit medium to rather large, roundish or roundish oblong; stem medium to long; skin thin, clear, bright-yellow, bright-red cheek covered with bloom; flesh yellow, crisp, juicy, somewhat astringent, sub-acid; very good for culinary use. Late August to middle of September.

Whitney. One of the most popular of the large crabapples for the West and North for dessert and culinary use. Tree below medium size, upright becoming somewhat spreading, bears early, productive; fruit large, roundish inclined to conic; stem slender; skin light yellow shaded and striped with red; flesh yellowish, crisp, juicy, sub-acid or nearly sweet, flavor good to very good. Late August to September.

APRICOTS

Alexander. Medium-sized, skin orange-yellow, red blush, juicy, sweet, early freestone, prolific, poor quality. Russian.

Alexis. Large sized, yellow with red blush, sub-acid. Russian.

Black (Noir, Violet). Small to medium pale-red shaded to dull deep-purple or nearly black in the sun. Flesh red near the skin, yellowish at the stone, hardy. Little value.

Blenheim. Fruit similar to Royal. The leading variety in California. Needs thinning for canning in order to secure size. Regular and prolific bearer. Subject to brown rot in the coastal region of California. Recommended for the coast for canning and drying.

Breda. Small to medium, orange with dark-reddish cheek; flesh deep orange, rich, high flavored; early, hardy, productive.

Early Golden. Small, pale orange; flesh orange, sweet, good, juicy; early, hardy, productive.

Gibb. Medium size, light-yellow, sub-acid, juicy, rather poor, early, freestone. Russian.

Harris. Medium size, yellow, red cheek, juicy, hardy.

Hemskirke. Fruit large, roundish, flattened; skin orange with red cheeks; flesh bright-orange, tender, more juicy than Moorpark, rich flavor, stone rather small, bitter. Valuable for home use. A shy bearer in places.

Montgamet. Small, deep-yellow, early, suitable for preserving.

Moorpark. Fruit larger than Royal, Blenheim or Tilton. Trees very large, robust, vigorous, a shy bearer in some places. Fruit matures late. A profitable variety for drying in California.

Newcastle. Size medium, round, not so large as Royal nor so high in flavor; skin highly colored; early, regular, good bearer, medium grower; ripens three to four weeks earlier than Royal. The chief early shipping variety from California.

Orange. Medium size, orange skin with ruddy cheek; flesh dark-orange; of but moderate quality.

Peach. Very large in size, skin yellowish-orange with brownish-orange cheek; flesh yellowish, juicy, rich; resembles Moorpark but is larger.

Royal. Fruit roundish, medium to large, oval, slightly compressed; skin dull-yellow with orange cheek; flesh pale orange, firm, juicy, rich flavor; freestone; productive. For several years it was the leading variety in California for drying and it is excellent for canning.

Tilton. Fruit large, symmetrical; flesh a fine yellow, freestone. Its drawback is that it colors before it is ripe. A favorite in the Sacramento and San Joaquin Valleys. It blooms two weeks later than Royal or Blenheim and avoids injury from early frost. Tree strong, healthy, vigorous and productive. Recommended for San Joaquin Valley for drying and canning, also with Blenheim for the Sacramento Valley, California.

AVOCADOS

The following list contains only varieties of relative importance; new varieties are rising into prominence and some of these may be passing:

MEXICAN RACE, THIN SKINS

Carton. Purplish-black, pyriform, 6 to 8 ounces; seed rather loose; flavor rich; tree hardy, productive. October to November in California.

Chappelow. Purplish-black, glossy skin; shape bottle-necked; 5 to 8 ounces; seed small, tight; flavor very rich; tree vigorous, hardy, fairly productive. August to November in California.

Ganter. Green, smooth oval fruits; 4 to 9 ounces; seed small to medium, loose; flesh rich flavor; tree hardy, vigorous, very prolific. October to December. Fruit is apt to decay at apex even while on the tree.

Gottfried. Dark brownish-purple, pyriform; 12 to 20 ounces; seed small; flesh rich flavor, very good; August to October. Tree large, hardy in Florida.

Harman. Purplish-green, size 5 to 10 ounces; seed, large, loose; flesh very rich; tree unusually vigorous, prolific. October to December. Fruit tends to crack at apex when ripe.

Northrup. Purplish-black, obovate to pear shape; 4 to 7 ounces; seed medium size, tight; flesh rich flavor; tree very hardy, vigorous, produces a large fall crop in October to November and a small spring crop. April to May in California.

GUATEMALAN RACE, HARD-SHELLED
(On trial in California)

Blakeman. Green, pear-shaped, 16 to 20 ounces; seed small to medium, tight; flavor rich. Tree strong grower, fairly hardy. May to July. Oil content 21.5 per cent.

Challenge. Dark-purple; spherical, medium to large, 14 to 18 ounces; seed very large, tight; flavor not so rich as others; tree moderate grower, slender, difficult to bud, prolific. February to May. Oil content low.

Colorado (Purple Murieta). Dark purple, obovate, 14 to 18 ounces; seed medium size, tight; flavor very rich; tree rather weak, difficult to propagate, moderately productive. April and May.

Dickey. An excellent fruit, season May to July, but difficult to propagate.

Eaglerock. Green, round, of excellent quality; 25 to 40 ounces.

Fuerte. A good commercial variety; green, pear-shaped, 12 to 14 ounces; seed small, tight; flavor rich; tree unusually strong, erect grower, easily propagated. January to August. One of the hardiest.

Linda. Deep-purple, round, size 2 pounds. Seed medium, tight; flavor rich; tree vigorous, hardy, productive. October to March in Gautemala. Oil content 14 per cent.

Lyon. Dark-green, pear-shaped, 14 to 18 ounces; seed small to medium, tight; flavor rich; tree not a strong grower, comes into bearing early, prolific, difficult to propagate. April to August. Oil content 26.5 per cent.

Meserve. Dark-green, roughened, oval to spherical; size 14 to 16 ounces; very rich flavor; seed medium size, tight; tree good grower, slender wood; productive. April to June in California.

Nimlioh. Very desirable in Florida. Green, oblong; size 24 to 40 ounces. February to March.

Puebla. Deep maroon-purple, pear-shaped; 8 to 10 ounces; rich nutty flavor. December to February in California. Oil content 26.45 per cent. One of the hardiest.

Sharpless. Greenish-purple to purple, pear-shaped; size 1 to 1½ pounds; rich flavor; seed small, tight; tree, tendency to be tall and slender; strong grower, productive. October to February in California. Oil content 18 per cent.

Solano. Bright-green, glossy, oval, size 1 to 1½ pounds; pleasant flavor, seed small, tight; tree prolific, fairly vigorous grower. March to May in California.

Spinks. Purplish-black, round, size 27 ounces; rich flavor; seed small, tight; tree early bearer and prolific. April to August in California. Oil content 18.5 per cent.

Taft. Dark-green, pyriform, size 14 to 25 ounces; rich flavor; seed medium, tight; tree, one of the hardiest, vigorous, productive and easily propagated. May to October in California.

Walker. Dark green, pyriform; size 5 to 8 ounces; rich flavor; seed very large, tight; tree vigorous, early bearer and productive; easy to propagate. May to August, fruit sometimes hanging to October. Oil content 16 per cent.

West Indian Type
(Grown in Florida)

Barker. Resembles Pollock but is probably more hardy.

Family. Maroon-colored, slender pear-shaped; size 10 to 14 ounces; mild, pleasant flavor; seed large, tight; tree vigorous, tender; very productive; July to end of September in Florida.

Pollock. Light-green, somewhat pear-shaped; size 1½ to 3 pounds; rich flavor, seed not large, almost filling the cavity; tree vigorous, tender, not prolific; tendency to biennial bearing. August to September in Miami.

Trapp. Yellowish-green, roundish oblate; size 14 to 20 ounces; fairly rich flavor; seed large, loose; tree tender, rather lacking in vigor, early and prolific bearer. October to December with some fruits hanging to February in South Florida. In Florida the trees are dwarf and stocky and are usually planted seventy to the acre. The trees are given little pruning.

BANANAS

Cavendish or Dwarf. Will grow in Florida.

Cuban Red. The common red banana of commerce.

Martinique, Great Michael, Jamaica. The standard commercial yellow banana. Good shipper. Will grow in Southern Florida.

Hart, Hart's Choice. One of the hardiest; rapid grower; productive; will grow in northern and central Florida.

Orinoco. Hardy, suitable for northern and central Florida.

BLACKBERRIES

Agawam. Fruit medium, bright black, juicy, sweet, excellent flavor; early; canes slightly sprawling, stout, very productive, hardy; long season.

Ancient Briton. Fruit medium, oblong to oval, sweet, very good; midseason; canes bushy, hardy, productive; grown in Central West, Wisconsin.

Atlantic Dewberry. The late Dewberry. Season August and September, after all blackberries except Nanticoke are gone. Fruit jet black, firm, good shipper; canes vigorous. In the East, plant 5 feet apart in rows 7 feet wide on land well supplied with moisture. It ripens its fruit so late it needs plenty of water.

Blowers. Berries large, jet black and of finest flavor. Plants very strong, upright growers, moderately hardy, productive. Ripen during July and hang on well. Sometimes fails to set fruit.

Early Harvest. The earliest standard berry. Fruit medium size; bright, glossy black, juicy, sweet. Plants upright growers; not hardy in the North; popular in the Central and Southern states and on the Pacific coast.

Eldorado. Berries medium to large, black, excellent flavor. Plant very hardy, productive in Ohio. Suits Central states. Said to be a shy bearer in some places. Sells well; excellent for home or commercial use.

Erie. Large, globular, sprightly; canes upright; vigorous, productive. A good market berry, winter kills in North.

Evergreen. A hardy productive late berry, grown on Pacific coast. Valuable for home or commercial use.

Himalaya. A much-advertised variety. Too tender for the East. Is planted west of the Cascade mountains where it is a productive, rank-growing viny plant.

Iceberg. Berries white to cream color, translucent, early; plants upright growers, self-sterile, needs Early Harvest to pollinate it. A novelty and for home use only.

Joy. Berry large, almost as thick as long; black; excellent flavor; very hardy, productive. Midseason.

Kittatinny. Fruit large, glossy black, moderately firm, nearly sweet, rich; medium to late; canes vigorous, moderately productive. Subject to winter injury in New York. Good home use berry. Fruit loses in color and appearance after picking.

Leader. Berries very large and of the best quality, very productive; good seller; fine vigorous canes.

Lucretia Dewberry. The most valuable and popular dewberry. Thrives on most soils; needs winter protection in New York; earlier and larger than a blackberry; productive, fruit large, handsome, rich black, quality the best.

Mayes (Austin) Dewberry. Fruit very large, good quality, very early, a week ahead of Lucretia, productive. Canes trailing when young, more upright later. Suits Middle West to Texas. Useful for home or nearby market in East.

McDonald Dewberry. Sometimes listed as a blackberry. Is earlier than Early Harvest and berries larger and of good quality; canes vigorous and creeping the first year, afterwards more erect. Needs the Mayes Dewberry to furnish pollen.

Mammoth. Fruit large, black, good; vines of trailing habit, not entirely hardy in New York.

Mersereau. Known as Maincrop in Missouri and Best Late in Texas.

Fruit very sweet, luscious, little core, good black color; late or midseason; strong, upright grower, resistant to rust. Shows some winter injury in Western New York.

Minnewaska. Medium to large, nearly round, moderate quality; midseason, winter kills.

Nanticoke. Berry medium to large, sweet, juicy, excellent. The latest of blackberries, extends the season to September. Canes strong growers, hardy, productive. Fruit does not ship well; excellent for home use and nearby markets.

New Rochelle (Lawton). Old variety; late, vigorous; usually hardy. Grown in Oregon.

Ohmer. Fruit medium size, fair quality, varies in productiveness.

Premo. Worthy of trial.

Rathbun. Berries large, jet black, good shipper, good flavor, small seed, soft core. Midseason; canes sprawling, semi-hardy. Supposed to be a cross of Wilson and a dewberry.

Snyder. One of the oldest varieties. Berry medium size, firm, sweet, juicy and good. Extremely hardy even into Canada; subject to anthracnose. If blackberries fail, try this one.

Taylor. Fruit medium to large, oblong, juicy, sweet, good. A good late berry; canes moderately vigorous, hardy, productive. Indiana. Has not done well in Western New York.

Ward. Berries large, tender, sweet, excellent quality with little core; vigorous grower; productive.

Watt. Fruit large, jet black, excellent; plant strong grower, desirable, might be more resistant to disease. Fruit hangs on well from early season to late making it valuable for home use. Good shipper, worthy of trial.

Wilson. Large, black, good; early, very productive south of Philadelphia. Not hardy in North.

Wilson, Jr. Medium to large, juicy, good. Like Wilson, not hardy in North, good in South.

BLACKBERRY-RASPBERRY HYBRIDS

Humboldt. Seedling of a dewberry and Cuthbert, shows characters of both. Purple berries, very large.

Paradox. Seedling Crystal White blackberry and Shaffer raspberry. Berries light-red, large.

Southern Blackberries Suitable for Florida

Rubus cuneifolius. Ripens in May and June. Fruits good size.

Rubus hybridus. Northey berry. A dewberry in habits of growth; fruits purplish, good size, excellent flavor. Ripens April to May.

Rubus trivialis. Manatee dewberry. • Fruit black, delicious, ripens April to May. If thrips attack southern blackberries while in bloom, spray or dust with nicotine preparations.

BLUEBERRIES

The following descriptions, were furnished by Miss Elizabeth C. White, of New Jersey. These are all highbush blueberries or hybrids.

Adams. One of the earliest; berries uniform, up to five-eighths inch diameter, medium blue, pear-shaped, excellent flavor; bush symmetrical, dark green leaves of heavy texture, productive.

Cabot. (Coville hybrid 834A). Early; berry large; flavor one of the best.

Dunfee. Berries large, dark-blue; excellent; early; foliage heavy texture, mottled with grey lines, later deep glossy green.

Grover. Late, berries of largest size; flavor the best; bush strong, vigorous.

Harding. Late to very late; excellent for home use and nearby market; too tender to ship; berries sweet, excellent flavor, large, dark-blue; plant vigorous.

Katharine. (Coville hybrid 830C). Mid-season to late; berries large; foliage rich green, heavy texture.

Pioneer. (Coville hybrid 620A). Late. Berries large, light-blue, streaked, of good flavor; foliage heavy texture; productive.

Ralph. Early; berries lack size; uniform, light-blue, good flavor, borne in large drooping clusters; bush compact, productive.

Rubel. Very late; one of the largest; berries somewhat acid; excellent shipper; bush large, strong grower, productive.

Sam. Mid-season to late; berries uniformly large, borne in large clusters, light-blue, delicious flavor; foliage heavy with a bluish-green bloom.

The Blueberry of Florida is

Vaccinium virgatum. A strong shrub. Plant in rows 15 to 20 feet wide, plants 10 to 12 feet apart. Fruits ripen May to August. Equal to New England blueberries in size and flavor.

CACTUS—TUNA

Among Burbank's seedlings are:

Bijou. Hardy, smaller than Elegant.

Elegant. Seedlings of New England, hardy, *Opuntia vulgaris X O. rafinesquii*; fruits 1½ inch by three-quarter inch, scarlet; plants hardy, almost spineless; spring.

Superb. Seedling Smith x Anacantha; large fruits, pale-yellow, shaded olive-green and crimson; thin skin; flesh pale-amber, rich, sweet, very good, almost seedless; October and stays in good condition for four months.

Whitefruit. Fruits large, oval, white; the most delicious of all.

CHERRIES

With the exception of the Pacific Coast, the sour cherry is usually planted. Ninety per cent of the trees east of the Rockies are sour. The leading commercial varieties are Montmorency, Early Richmond and English Morello. The most popular sweet varieties in the East are Napoleon, Windsor, Lambert, Black Tartarian, and Wood, and lately Schmidt has many advocates. On the Pacific Coast Napoleon (Royal Ann) is in the lead. None of the Duke cherries are of commercial importance.

Hedrick lists 270 varieties of sour cherries and 549 of sweet cherries and 65 of Dukes. The following descriptions are made from Hedrick's The Cherries of New York:

D = Duke. Sour = Sour. S = Sweet. Big. = Bigarreau. Heart = Heart.

Abesse D'Oignies. (D.) Fruit large, dark-red; excellent quality; good shipper; season late: tree large, vigorous, hardy, fruitful, free from fungus troubles. One of the best of the Dukes.

Bessarabian. (Sour.) Small, sour, astringent, but the tree is hardy, healthy, dwarfish. Used in the colder parts of the Central West.

BING. (S. Big.) Takes high rank on the Pacific coast. Fruit very large, dark-red, almost black, very good quality; good shipper. Mid-season or later. Tree large, vigorous, productive.

BLACK TARTARIAN. (S. Heart.) A standard variety east of the Mississippi, shows a wide range of adaptability, is fruitful, healthy, robust and long-lived and fairly free from brown-rot. Fruit medium in size; dark-red flesh; juicy and very good in quality. A little too small to can but fruit matures early. An excellent kind for home use or nearby markets.

Brusseler Braune. (Sour.) Has been advertised for cold climates but there are better varieties for such places. Fruit matures very late.

Carnation. (Sour.) An old variety, useful for home use only; fruit mid-season.

Chase. (Sour.) Fruit resembles Morello but the tree is a better grower. On trial in the East.

Cleveland. (S. Big.) Fruit medium to large; light-yellow, red cheek; mid-season. Not commercial.

Coe. (S. Heart.) One of the best early sweet cherries for home use or nearby market; fruit good size, yellow with red blush; tree hardy, healthy, productive, vigorous.

Downer. (S. Heart.) One of the best late sweet cherries; medium-sized fruit, dark-red, good quality, large pit. Tree fastidious as to location, often lacks vigor. Useful for home orchard.

Dyehouse. (Sour.) Like Early Richmond, but a week earlier; is smaller and the tree is less vigorous; the fruit and tree are both small.

Eagle. (S. Heart.) Fruit medium, black and of excellent quality; its defect is lack of size of fruit. Ripens just after Black Tartarian. Tree hardy, healthy, vigorous; excellent for home orchard or a market wanting a high quality fruit.

Early Purple. (S. Heart.) A very early dark-red, high-quality cherry; suitable for home use or local market; fruit of good size; but the tree demands a free warm loam in order to thrive.

Early Richmond. (Sour.) The leading early commercial sour cherry. Fruit medium in size and but fair in quality; not a good shipper. It can be canned and formerly was dried as a sweetmeat. The tree will thrive in all kinds of situations all over the country and this is its strong point. It ranks second to Montmorency among sour cherries.

Elton. (S. Heart.) An excellent yellow cherry with red overcast, of high quality and desirable in every way except that it is extremely liable to brown rot and the tree is apt to be injured by cold; these prevent its extensive commercial planting. Fruit matures early and is of good size.

Empress Eugenie. (D.) Fruit medium size, dark-red. Its defects are the fruit ripens unevenly and are borne in clusters so that when brown-rot is prevalent all succumb. Its short stem makes picking difficult and the tree is a very dwarf grower, useful for home gardens.

English Morello. (Sour.) The best cherry of its group and the standard late sour cherry for home use, market or cannery. It is handsome in appearance, dark-red; can be handled and shipped easily. Resists brown rot and hangs on well. The trees are small, round-headed and drooping and need to be planted close together to secure tonnage off an acre.

Ida. (S. Heart.) A handsome large, light-red cherry, resembling Napoleon in shape; flesh tender, melting, good quality; early; the tree is a good grower, hardy in bud but some places report the fruit too soft and too apt to succumb to brown rot to be of commercial use. It is of value for home use.

Kirtland. (S. Big.) Fruit yellow with red overcast, resembling Napoleon; high in quality; flesh firm and meaty and resists brown-rot as well as any. Its defect is that the tree needs extra care and with such will grow only on the choicest of soils; but for this it would be one of the best early cherries to plant.

LAMBERT. (S. Big.) One ofthe best of the new cherries originated in Oregon, where it succeeds. It is doing well in the East. It is dark-red, meaty, juicy, very good flavor. The tree is vigorous, hardy, strong, healthy and regular in bearing. The fruit ripens in midseason and is of good size.

Large Montmorency. (Sour.) This variety would be the leading sour cherry if it were more productive. It differs from the ordinary Montmorency in that its fruits are larger; they have a short, thick stem; ripen a little earlier and are usually borne singly on the branch. It is a shy bearer and is not of commercial value. Most of the trees sold as Large Montmorency are the Montmorency Ordinaire.

Late Duke. (D.) Is a variation from May Duke; it ripens two to four weeks later. It is a valuable variety for the home orchard and local markets. On a north wall the fruits will hang until August. The fruit is of fine quality and the tree is hardy and productive.

Louis Philippe. (D.) A cross of a sweet cherry on a sour of the Morello type, the fruit partaking of the Morello in appearance. It seems to be almost identical with Olivet except for the time of ripening and that the tree looks more like a Morello than Olivet does.

Lyons. (S. Heart.) An extra early market cherry for dessert purposes, worthy of trial. Fruit large, dark-red, very good quality. The tree is vigorous and a rapid grower. It is believed by Hedrick to be well worth while trying commercially.

Magnifique. (D.) This fruit is a large, pale-red to bright-red cherry and one of the latest to ripen. It has pale-yellow flesh. The tree is a spreading grower, productive. The fruit ripens unevenly. A home garden or local market cherry.

May Duke. (D.) One of the oldest and most popular cherries; thrives in many climates and soils; for over two hundred years it has remained a leader. The fruit ripens unevenly; ripens early but hangs on for six weeks; dark-red when ripe and is then a dessert fruit. Tree is hardy, vigorous and productive.

Mercer. (S. Big.) At Geneva, N. Y., this variety shows four defects— the trees are unproductive; the cherries are small; flavor is not good; fruit is subject to brown rot. The fruit is black with reddish flesh and is on probation.

Mezel. ((S. Big.) A dark-red cherry which in spite of much advertising failed to establish itself. The tree is vigorous and healthy, but not productive.

*__MONTMORENCY.__ (Sour.) The most popular cherry in America. The fruit is smaller than that of Large Montmorency; it is medium to large in size, light to dark-red in color, with pale-yellow flesh. The tree is vigorous, healthy and very productive, and adapted to a wide range of territory. The fruit can be used before fully ripe; is fairly resistant to brown rot; ships well and is the leading canning cherry in the East.

NAPOLEON (Royal Ann). (S. Big.) The leading firm flesh sweet cherry. The fruit ripens in midseason; is pale-yellow with a red overcast, large, handsome and of high quality; flavor is rich, sweet, excellent; flesh firm. The trees bear early and are hardy, vigorous, healthy, productive and upright growers. The fruit is apt to crack in wet weather. In Oregon, Washington and California it reaches perfection; in the East it sometimes suffers from brown rot. Good for home or commercial use. "In California Napoleon and Black Tartarian constitute about 70 per cent of the crop produced and about 90 per cent of the amount marketed." (Wickson.)

Nouvelle Royal. (D.) A large dark-red cherry, midseason to late, of good quality. The tree is unproductive.

Olivet. (D.) A large globular, deep-red cherry, tastes like a good Morello; one of the earliest of the Morello-like cherries. The trees are large and vigorous, but not fruitful. Several types of Olivet are on the market.

Ostheim. (Sour.) Used in the prairie states of the Central West. It is a poor Morello; very dark-red; matures late and is hardy, useful for cold regions.

Oxheart. (S.) Commonly applied to a group of white-fleshed cherries, as Yellow Spanish, Napoleon or White Bigarreau.

Reine Hortense. (D.) Useful for the amateur. A large amber-red midseason cherry, with pale-yellow flesh of excellent quality. The trees demand a choice soil and lots of care and are usually not productive.

Republican. (Lewelling) (S. Big.) This large black-red has fine flavor and is of excellent appearance if grown on a choice soil, while elsewhere it is a small indifferent cherry.

Rockport. (S. Big.) A seedling of Yellow Spanish and resembles it. Its faults are a large pit and little flesh; is a poor shipper; subject to brown rot. The tree lacks hardiness; it matures early and may be used by the amateur.

Royal Duke. (D.) Royal Duke matures between May Duke and Late Duke. The cherries are larger and a little lighter in color than May Duke; fruit is pleasant and of good flavor.

SCHMIDT. (S. Big.) This large, dark-red, almost black cherry has crisp, firm, juicy flesh of excellent flavor and of a ruby-red color. It is almost immune to brown-rot and is an excellent market fruit. The tree is vigorous, healthy and productive and bears an abundance of dark, luxuriant green leaves. One of the best commercial cherries.

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* Leading commercial varieties.

Short-stem Montmorency. (Sour.) It differs from Large Montmorency or Montmorency Ordinaire in that the tree is smaller, more drooping and is usually very productive. The fruit is large and has a characteristic very deep, wide suture becoming an indistinct line at the apex. The skin is not as dark-red, the quality is not as high, nor is it as desirable as either of the other two sorts.

Späte Amorelle. (Sour.) A dark-red hardy cherry, small and probably of value for a region needing a hardy tree.

Suda. (Sour.) Like English Morello, but the tree grows more upright and is not so productive.

Timme. (Sour.) Like Early Richmond; productive, but small.

Vladimir. (Sour.) A Morello type, which it much resembles, save that the tree is more dwarf. It is very hardy and is used in regions seeking this character primarily.

WINDSOR. (S. Big.) One of the most profitable sweet cherries grown. The fruit is large, black-red, with light-red flesh and of very good quality. It stands harvesting and shipping well; is not subject to brown rot. The tree is one of the hardiest and least fastidious of all sweet cherries. It originated in Canada. The tree grows upright and the fruit is apt to be borne in clusters. It ripens in late midseason and is good for home or market use.

Wood. (S. Heart.) The fruit is yellow with a red blush; its flesh is soft and will not stand shipment. It is susceptible to brown rot and the fruit is apt to crack; is beautiful and comes early. The tree is tender to cold and fastidious as to soil, otherwise is vigorous and bears early. This variety is suitable for home use or small local markets.

Wragg. (Sour.) Appears to be identical with English Morello and most nurserymen mark them interchangeable.

YELLOW SPANISH. (S. Big.) Something like Napoleon. Yellow Spanish is much older. It ripens after Wood and before Napoleon. It is a yellow cherry as its name implies, fruit not quite as large as Napoleon but it is of better quality. The fruit is somewhat subject to brown-rot. The tree is one of the best of growers, the largest of all; it is vigorous, bears early and abundantly, with its crops well distributed, not in clusters; of value for home or commercial use.

CITRANGES

Rusk. Grafted trees often bear in three years, and are quite prolific. The fruit is about 1½ to 2 inches in diameter. The peel is quite disagreeable and must be kept out of the juice. One of the most extensively planted.

Colman. Fruits large, 3 to 3½ inches, acid, light-yellow.

Morton. Fruit the largest of all, weighing one pound, usually seedless. Tree vigorous grower, cold-resistant.

Saunders. Fruit small, 2 inches to 2½ inches. Thick skin, juice acid. The most cold-resistant of all, so far.

Etonia. Grown for its large flowers.

Cunningham. Fruits small, juice acid.

Savage. Fruit medium to large; light-yellow; juice acid. Tree vigorous, prolific, bears dense foliage.

CITRONS

Lemon. (Sorrento). Form oblong; size variable; large fruits 8 inches long and weighing 3 to 8 pounds; color lemon-yellow; rind smooth, 1 to 1¼ inches thick; fruits throughout the year in favorable locations. Grown in California and to some extent in Florida.

Lyman. Form oval oblong; side medium; color orange-yellow.

Orange. Form somewhat cone-shaped; color orange; rind cream-colored, sweet, aromatic; flavor fruit less bitter than ordinary; tree small, stiff, erect grower according to Florida grower's report.

Corsican. Fruits large; introduced from Corsica, the best commercial variety for Southern Florida.

CRANBERRIES

The fruits are usually classified according to shape. The three common types are the Bell, Bugle and Cherry. The Bell and Bugle types have gone ahead as fancy varieties. A fourth type, the Olive, embraces olive-shaped varieties which are large and apt to be light colored or do not color until late. Bell and Cherry are two sub-groups; natives in Wisconsin. These are not fancy berries and constitute 60 per cent of the output. Bell and Bugle are a type considered fancy in Wisconsin.

Early Black. The first variety to ripen. Fruit nearly round in shape, medium size. The fruit is of much better storage value if not harvested too soon. It is subject to bitter rot. On Cape Cod probably 50 per cent of the acreage is planted to this variety.

Early Red. Fruit round in shape, good size.

Metallic Bell. Bell shape, highly colored.

Mammoth (Holliston). Shape oblong; extra large; fine flavor.

Matthews, Centreville and **Chipman** as grown in New Jersey are all much alike. Bugle shaped, medium large size, bright-red color.

Centennial. Shape round; large size; extra fine flavor; medium red color. Late.

Bennett's Jumbo. Oblong shape; large size, medium bright-red; fine flavor; good keeping quality.

Searls Jumbo. Oval shape; bright-red color and large size.

McFarlin. Round shape; good to large size; fine flavor; medium bright-red; follows Howes in ripening.

Prolific. Round shape; large size; fine flavor; dark color.

Plum. So named from its shape and size, is extra large.

Native Jerseys. A class constituting about 30 per cent of the output of that state.

Smalley. Round or bell-shaped; medium to good size.

Late Howes. The main late variety in Massachusetts and New Jersey. A very good keeper; oval shape; medium to good size. Indications are that the fruit will show less "end rot" in storage if picking be not begun too early. Picking should not begin before the first week in October in Massachusetts. About 40 per cent of the acreage in Cape Cod and New Jersey is planted to this variety.

Pointed Howes. Pointed shape; large size.

Late Jersey. The native Jerseys are usually sold under this name. Fruit has medium size and color and good keeping quality.

Long Keepers. Round shape; medium size; fine flavor; very good keeper.

Champion. Oblong shape; large size; bright-red color.

CURRANTS

RED CURRANT VARIETIES:

Chautauqua. Vigorous, easily picked; clusters long; berries large; not commercial.

Cherry. A trade name applied in many markets to any good-sized red currant. The variety originally listed under this name had a large berry, short cluster and was unproductive, and is not grown.

Comet. Similar to, if not identical, with Fay.

Diploma. New, productive, upright grower; fruit light-red, mild flavor. On trial.

Fay. Sprawling bush; fruit large, dark-red, medium productive; easily harvested.

Filler. Mediocre in productivity and size of fruit.

Knight's Large Red, Pomona, etc. Badly mixed. There are better varieties.

North Star. The plants now offered under this name are *Red Dutch.*

Perfection. Bush lops, moderately vigorous; fruit large, good quality, light-red, mild flavor, midseason.

Prince Albert, Franco-German, Holland, River's Late Red. Erect grower, typical foliage; medium size berry; medium bunch; latest of all.

Red Cross. Berry large, mild flavor. Has no merit.

Red Dutch (Pallnan). Fruit too small to be of commercial value. Grown in the Middle West.

Ruby. Mild flavor. Home use.

Versailles. Badly mixed; is frequently sold as Cherry; large fruit, good bunch, moderately productive.

Victoria, Raby Castle. Strong grower; healthy canes; poor to very productive; healthy foliage; fruit small and hard to pick; grows well on sandy land; late.

Wilder. Vigorous canes; fine foliage; healthy; medium to large berries, medium size bunch; late midseason. One of the good commercial kinds.

WHITE CURRANT VARIETIES:

White Grape. (Many synonyms). Large berry; attractive color; good flavor.

White Imperial. Mild, pleasant flavor, desirable for dessert.

BLACK CURRANT VARIETIES:

Boskoop Giant. Very promising; large fruit, long cluster; productive, one of the best.

Champion. Mild, nearly sweet; strong grower; often shy bearer.

DATES

Descriptions after Popenoe. Several thousand varieties have been recognized. A few dozen are of commercial importance. Some show desirable shipping qualities and are commercial in the same sense that are Ben Davis apples and Elberta peaches. Commercially they may be classified as ''soft'' and ''dry.'' These are poor terms because each type may be made from the other under certain conditions. Dry dates are easily packed and are not likely to spoil. Soft dates include almost all the valuable varieties save one, Thoory, which succeed in California. Three others, Asharasi, Kasbeh and Zehedy, may be classed as dry, but are softer than typical dry dates. Varieties may be classified according to the color of the fruit when mature as yellow or red.

Asharasi. The best dry date of Mesopotamia and can be used as a soft date. Succeeds in the United States. Midseason; fruit medium size.

Deglet Noor (Deglet Nur). Considered the finest grown in Algeria and Tunis. Highly esteemed in California for commercial planting. Season, late; size, large; requires a large amount of heat to ripen properly; fruit tends to ferment if kept for several months.

Fardh (Fard). The chief commercial date of Oman. On trial in California; while inferior in quality it is well known on American markets; keeps well and is a valuable commercial variety; size small to medium.

Rhars (Ghars). One of the commonest dates of North Africa. Size, large; ripens early, productive; the plant can grow in the presence of considerable alkali and under neglect; is a strong grower in California, but there are better varieties. The fruit ferments easily.

Halawy (Halawi). The great commercial date of Mesopotamia and ranked as the leading date of the world in regard to volume sold. Succeeds in California and Arizona. Fruit: size, large; good keeper and shipper, attractive color, mid-season.

Hayany (Birket al Hajji). An Egyptian date which is satisfactory for California and Arizona. Size, very large, midseason; tree bears early, prolific and is more frost-resistant than many other varieties.

Kasbeh. A valuable North African date, grows well in California. Fruit large, late; an excellent shipper and keeper, flavor good.

Khadrawy. An important commercial variety in Mesopotamia, ranking second to Halawy, but is a better date, somewhat darker in color; is growing successfully in California; size medium to large, midseason.

Khalaseh (Khalasa). One of the finest dates in the world. Is grown in the Persian Gulf. Prefers a dry situation and a sandy soil; an early but not a heavy bearer; on trial in United States.

Khustawi. A dessert date of Bagdad; well adapted to American conditions; not a heavy bearer, but the fruit keeps well; size small to medium; midseason.

Majhul. A large, good-keeping date from the Moroccan Sahara and probably adapted to only the hottest and driest regions of the United States.

Maktoom (Maktum). A Mesopotamian variety which has proven well adapted to California conditions, although not resistant to frost. It is large, of fine quality and a good grower, late.

Manakhir. A large-fruited Tunisian variety which so far has not produced dates of the best quality in the United States.

Thoory (Thuri). One of the best Algerian dates; large and of excellent flavor. Palms productive, clusters very large; has proven very satisfactory in California.

Zehedy. The principal commercial date of Bagdad; can be used as a soft or a dry date. Tree vigorous, hardy, resistant to drought, productive.

FIGS

Black Ischia. Size, medium to large; skin, bluish-black; pulp, crimson; quality, good; season, July. Strong grower, not a heavy bearer; hardy.

Brown Turkey (Turkey). Size, medium to large; pear-shaped; skin, copper-brown; pulp, whitish, shading to pink; quality, good to very good. This variety is very hardy, dwarf and prolific; is usually regarded as being as hardy as Celeste.

Brunswick. Size, large to very large; pear-shaped; skin, bluish-purple to dark-brown; pulp, white, or nearly so, shading to pink; quality, fairly good; season, midseason to late. Because of its handsome appearance, is very desirable for fresh fruit.

Celeste. Size, very small to medium, pear-shaped, ribbed; skin, violet to purplish-brown; pulp, whitish to rose-color; firm, juicy, sweet; quality, excellent; very desirable for canning and preserving; season, early. The most widely and extensively planted variety in the southern fig belt outside of Texas. Hardy. Can be grown where less hardy varieties fail.

Ischia (White Ischia). Size, medium; skin, pale-green; pulp, crimson; quality, rich, sweet, very good; very productive; season, late.

Lemon. Size, medium to large, faintly ribbed; skin, yellowish-green; pulp, white, sweet, soft; quality, fair to good, vigorous, prolific; season, early.

Magnolia. Size, large; skin, amber-colored; pulp, pinkish-amber; handsome; quality, fruit excellent for canning; vigorous grower, prolific; season, midseason to late. The favored variety along the coast in Texas, is not well adapted to the regions east of the Mississippi River where its growth is weak and the fruit cracks badly.

Nameless. Size, medium to large, with purplish-red skin; quality, good; rich, sweet flavor. It is claimed that this variety does best when cut back practically to the ground each fall after it becomes dormant, which enables the stubs to be completely covered with soil, thus giving effective winter protection in regions where such is required.

SMYRNA FIGS

Lob Ingir. Dried product marketed under trade name ''Calimyrna.'' Size, large to very large; flattened; skin, light-brown, shaded to green; pulp, pale to dark-amber; quality, one of the best; tree, strong, spreading, straggling grower; splits easily.

Purple Smyrna. Size, medium to large, pear-shaped, flattened; skin, brownish-purplish, shaded to greenish; pulp, reddish-brown; quality, good; tree, large, spreading, strong grower.

Cordelia. Size, large, pear-shaped; skin, yellowish, with greenish shading; pulp, amber colored; quality, very juicy, sweet. This is one of the sweetest figs, and has the characteristic very dry zone of this type of fruit.

San Pedro Black. (Various Syn.) Two crops. First crop very large; second crop smaller, oblong. Skin, smooth, violet-black, greenish on the neck; pulp, coppery-red, tinted with violet; quality, very sweet, with a light, disagreeable odor and bitterness; tree, very strong grower, requires moist, rich soil. First crop is an excellent table fruit; second crop dries well but is inferior in quality to the first.

San Pedro White. (Various Syn.) Usually bears two crops, first maturing without caprification. Size, large, rounded, three to four inches in diameter; skin, bright-yellow color, shaded to green, looking something like a lemon; second crop is deep sea-green with no yellow; pulp, deep bright strawberry-red; quality, fine, juicy, high flavor, acid in the case of the second crop, first crop often insipid. The second crop, which is caprificated, is much more desirable than the first; requires deep, rich soil and plenty of moisture

GOOSEBERRIES

American gooseberries have been grown where mildew abounds. None could survive unless relatively resistant to it. English were grown where, until recently, mildew was unknown and they are attacked by it. English gooseberries bear larger fruit and the plants have thicker and more glossy foliage.

AMERICAN GOOSEBERRIES:

Carrie. Resembles Houghton. Fruit red, good flavor, small.

Oregon, Oregon Champion resembles Downing.

Downing. The standard; pale-green, excellent flavor and quality; medium size. A cross between Houghton and a European gooseberry.

Houghton. Prolific, very much planted; fruit is too small.

Pearl. Similar to Downing.

Poorman. Reddish fruit, of medium size; bushes vigorous, large, productive, very promising.

EUROPEAN GOOSEBERRIES:

Chautauqua, Triumph, Wellington Glory, etc. Pale-green, excellent flavor and quality, good size, very productive.

Columbus. Resembles Chautauqua.

Industry. Dark-red when ripe; high quality; good size, productive.

Portage. Resembles Chautauqua.

Lancashire Lad. Dark-red, midseason, good shipper.

Whitesmith. Pale yellowish-green; sweet, very good, vigorous bush.

GRAPES: AMERICAN GROUPS

Descriptions after Hedrick's "The Grapes of New York."

Agawam. Berries large, oval, purplish-red in color; rich, sweet in flavor. Bunches large; vines vigorous. Fruit keeps well, ripens soon after Concord.

Bacchus. Berries medium to small, black; vine, vigorous, healthy, productive; flowers sterile. Fruit used for wine making; ripens well. Unsuited to soils rich in lime.

Barry. Rogers No. 43, one of our best black grapes; ripens with or after Concord; will keep to February; vines vigorous, hardy and productive; subject to mildew; excellent for home use; flowers sterile.

Beta. A hardy, good quality grape; will grow in Wisconsin and Minnesota.

Brighton. Color red, high quality, handsome; earlier than Concord, productive; vine strong grower, adaptable to various soils. It is sterile, needs a pollenizer. Fruit deteriorates in quality rapidly after maturing; good for home use.

Caco. A hybrid of Catawba and Concord but not so good as either in New York. Bunches small, fruits resemble Catawba.

Campbell Early. Fruit dark-purple in color with small seeds, ripens two weeks ahead of Concord, fruits are attractive and of high quality when mature with rich, sweet flavor. It is fastidious as to soils, being unproductive on some.

Catawba. The standard red grape, excellent keeper, lasts until March or later; excellent quality. The vine is vigorous, hardy and productive; foliage and fruit are subject to fungi; being late in ripening it succeeds only in favored sections in New York.

Clinton. It is valuable only for wine and culinary purposes; fruit is small and sour; vines vigorous, hardy and productive and need a lot of space.

CONCORD. The leading native grape, constituting 75 per cent of the total placed on the market. Color blue-black. It is essentially a Northern grape; suffers from fungi and insects in warmer climates. It is adaptable to many soils; hardy, blossoming late in the season, thus avoiding late spring frosts. Vine productive, relatively free from disease. The seeds are large and abundant; skin tough, quality moderate. It is an excellent shipper and is used for this purpose and the manufacture of grape juice. A vine should be included in every collection for the home garden in North Eastern America.

Cynthiana. One of the best Southern grapes for red wine, is somewhat particular as to soil, preferring sandy or gravelly loam, does not thrive on clay or limestone; is better in flavor than Norton which it resembles; fruit ripens very late and keeps well; very small and roundish and black in color.

Delaware. The standard in quality among grapes and after Concord the most popular in New York for garden, vineyard and for wine. The fruit is red, small size, attractive in appearance, keeps well and ships well; it ripens ahead of Concord. The vines are hardy, adapted to various soils, but succeed best on deep, rich, warm soils. The vines are small, slow growers, subject to mildew.

Diamond. For beauty and quality it is the leading green grape; it is early, hardy, productive and vigorous and can be grown where Concord succeeds. It is excellent for home use.

Diana. A seedling of Catawaba which it resembles, but it ripens two weeks earlier. Vines are tender, need protection in parts of New York. It is a shy bearer in some places. Fruit and foliage are subject to fungi. It is satisfactory for home use and local markets in certain sections; does best on poor, dry gravelly soil.

Dutchess. Of value to the amateur; fruit ripens in mid-season, keeps well; berries medium size, yellowish-green, sweet, rich, bunches large and compact. It should not be grown on a rich soil nor be over-pruned; it is subject to fungi, but is an excellent home-use grape.

Eclipse. Resembles Concord, but the berries and bunches are smaller, and it is several days earlier and much better color; vines are hardy, healthy, productive. Fruit hangs on the vine well and will not crack in hot weather; good for home use or local market.

Eaton. Resembles Concord but is not so good in flavor; ripens a few days earlier. Vines healthy, vigorous, hardy and productive, but the fruit is soft, does not ship well; it is declining in favor. Flowers sterile.

Empire State. A very good green grape; vines vigorous, productive, free from fungi and insects; bunches and berries have good size; very good quality, ships well and ripens ahead of Niagara.

Elvira. A good wine grape in Missouri, hardy and free from disease; is largely grown for wine making; fruit is green and ripens with Concord; does not keep well.

Eumelan. Berries black, ripening in mid-season but can be kept until winter; vines vigorous, hardy, inclined to mildew; worthy of trial for home use; difficult to propagate.

Gaertner. One of the best of Rogers hybrids, resembles Massasoit, but is of better quality; fruit ripens with Concord, dark-red, large; clusters large and showy; ripens unevenly and is a poor shipper; excellent for home use, somewhat capricious as to soils; flowers sterile.

Goethe. Another Rogers hybrid; fruit red, large, ripens later than Concord, in fact, too late for New York; it is a splendid table grape, does best on sands or gravel; excellent for home use.

Grein Golden. A very good white wine grape for the Central West; vines hardy, productive; flowers sterile; fruit ripens about with Niagara, does not keep or ship well.

***HERBEMONT.** In the South it occupies the same position that Concord does in the North; it cannot be grown north of the Ohio River, being too tender and requiring too long a season. Grown from Virginia and the Gulf to Texas, in which region it is vigorous and healthy. Fruit red-black in color and is used for a table grape and for wine. It requires well-drained warm soil well supplied with humus; it is difficult to propagate; does not do well on limestone soils; fruit is small in size.

Herbert. A Rogers hybrid. Color, blue-black; season with Concord; keeps well; sterile, needs a pollenizer. The vine is vigorous, hardy, and productive; excellent for home use.

Iona. An excellent flavored red grape, somewhat fastidious in its requirements; does well when trained against a wall. It needs winter protection in New York; excellent for home use; fruit ripens later than Concord; keeps well.

Isabella. Is of small commercial importance but may have a place

* Leading commercial varieties.

in the garden, blue-black grape, ripens with Catawba or earlier; keeps and ships well.

Ives. A small black grape, ripens about with Concord, but is not as popular as it was, its chief use being for wine.

James. Color blue-black, large berry; vines vigorous, healthy and productive; one of the best general purpose grapes for the South, but cannot be grown north of Maryland.

Janesville. One of the hardiest grapes we have, suitable for northern localities; vine healthy, vigorous and productive; should not be planted if a better grape can be grown. Berries dull black; keeps well.

Jessica. An early hardy, green grape, suitable in northern regions; clusters and berries small; is not popular where a better grape can be grown.

Jewel. Deep black grape resembling Delaware; early. It is to be recommended for the northern locations where Concord fails to ripen.

Kensington. A hardy green grape for northern gardens.

Lady. A light green and hardy grape; ripens two weeks ahead of Concord; fruit superior to Concord in quality, hangs well. One of the best seedlings of Concord; its buds and blossoms open late.

Lenoir. Dark purplish-black grape; berries small to medium; vines vigorous. It is a Southern grape, too tender for even the Middle States; a very good table grape, makes a dark-red wine; withstands drought well.

Lindley. A Rogers hybrid. A favorite in the garden; bunches medium size; fruit dark-red with rich aromatic flavor. Vines vigorous, fairly healthy; flowers sterile; the plants lack adaptability and need special care.

Lucile. An extra hardy grape, dark-red; it has a strong foxy taste and odor; pulpy and seedy; ripens ahead of Concord. In vigor, health, hardiness and productiveness the vine is unsurpassed.

Lutie. Resembles Lucile in vine, characters and in its failings.

McPike. A black grape, descendant of Concord, noted for its large berries; vine vigorous, hardy and productive; lacks quality.

Manito. A purplish-black grape, ripening with Moore Early. Recommended for both the North and South. Munson, the originator, claims it endures extremes of climate well and is worthy of trial in the South.

Massasoit. Berries are large, brownish-red and the fruit ripens with Delaware; keeps well and is the earliest vine of Rogers hybrids. The vines are vigorous, usually hardy, subject to rot and mildew.

Mills. A black grape with large berries which ripen somewhat earlier than Concord and can be kept until April; it is worthy of a place in the amateur's list. Vines are of medium vigor and not hardy, quite subject to mildew.

Missouri Riesling. A yellowish-green grape, which usually ripens later than Concord and does not keep or ship well; it is one of the good varieties for the South; vines vigorous, productive and healthy; an excellent wine grape when well grown.

MOORE EARLY. A black grape, ripening two weeks ahead of and like Concord; berries are apt to shell, the vines are not as productive as Concord and need rich, well-drained open soils and good cultivation. It is the standard grape for its season in New York.

Moyer. It is an early Delaware for northern regions, ripens two weeks ahead of its parent Delaware; berries dark-red; flowers sterile.

NIAGARA. The leading Eastern American green grape; vine vigorous, less hardy than Concord, productive; fruit ripens with Concord.

Noah. A southern green wine grape grown in Missouri.

Norton. The leading wine grape in Eastern America, showing great adaptability to soils; it can be grown as far north as New York, but it is essentially a southern grape. Berries small, black; clusters medium; vines vigorous, healthy.

Rommel. A green very good table grape and white wine grape sent out by Munson, Texas. Adapted to a warm climate.

Salem. Rogers hybrid; berries very dark-red, large; ripens slightly before Concord; keeps and ships well; clusters medium to large; flowers sterile; vines medium to vigorous, hardy and subject to mildew; fruit of high quality.

SCUPPERNONG. The great grape of the South. Of the ten cultivated varieties of rotundifolia now grown in the South, namely, James, Thomas, Eden, Meisch, Flowers, Memory, Ludlin, Tenderpulp, Geter and Scuppernong, all are black but the latter, which is green and chiefly used for wine-making; the berries drop from the bunch when ripe and are not attractive table fruit. The vines are vigorous, productive, not hardy in the North. The fruit ripens late even in the South. Most of these varieties are self-sterile. Recently plants capable of fertilizing themselves have been found in the varieties James, Eden, Thomas, Scuppernong and others, and in new plantations these improved and more desirable types should be used.

Triumph. One of the finest dessert grapes of America, requires a long season, and is adapted to the South and South West, prefers a deep soil. The fruit is a pale-green or golden-yellow, ripens with Catawba or earlier; does not keep well. Berries medium or above in size; vine vigorous, productive and somewhat subject to mildew.

Vergennes. Berries medium, red; ripens two weeks later than Concord; keeps and ships well; vines not always hardy; does best when grafted on another root. An excellent keeper, can be placed on the market in January.

Wilder. Purplish-black grape which ripens with Concord or earlier; one of Rogers hybrids; vines vigorous, hardy, productive, subject to mildew; flowers sterile.

Winchell. A very early green grape of very good quality; the berries and bunches are apt to be small and owing to the thin skin of the grapes they are apt to crack in shipping. In spite of this it is a standard early green grape. It is considered to be identical with Green Mountain; the vines are hardy, healthy and productive.

Worden. Berries, dark purplish-black to black; ripens one to two weeks earlier than Concord; does not keep well; vines are vigorous, hardy, healthy and productive; berries and bunches larger than Concord; not a good shipper.

Wyoming. Berries, dark dull-red; ripens a week to ten days earlier than Concord; vines vigorous, hardy, healthy, productive; flowers sterile; quality poor.

VINIFERA GRAPES

The Vinifera grapes are grown almost exclusively on the Pacific coast; some of the varieties grown in the East are hybrids of Vinifera and native grapes and for home use in the East some of the Vinifera may be grown if topworked on native roots and given winter protection.

ALEXANDRIA (Muscat of Alexandria). The leading table and raisin grape of the Pacific Coast; berries light-yellow, nearly transparent; skins thick; flesh firm, very sweet, rich; bunches long, loose, shouldered; vines vigorous, productive, short, straggling.

Alicante Bouschet. A popular red-juice grape.

Bakator. Berries dark-red with tender, sweet flesh, very good; bunches medium size, double shouldered, loose. High quality, desirable, early table grape. Good shipper. Suitable for the East.

Black Corinth. One of the best late black grapes, prolific, good shipper.

Black Hamburg. A popular local market black grape of standard quality; bunches large, broad shouldered; berries very large; skin thick; flesh sweet, juicy, rich, high quality. Makes good wine and raisins. Vines require little pruning. Can be grown in the East.

Black Morocco. A dull purple grape; bunches very large; berries very large; skin thick; although deficient in flavor, its fine appearance makes it excellent for commercial use, local market or shipment. Vine, strong grower, productive.

Blue Portugese. One of the early shipping varieties.

Chasselas Dorè, Palomino (Chasselas Golden). Berries medium to large, pale-green or yellowish; skin thin, tender; flesh soft, juicy, sweet; very good local market grape; bunches very large, shouldered; vines moderately vigorous.

Cornichon (Purple Cornichon) Vines very vigorous, productive; berries large, dark to black in color; quality moderate, excellent shipper; late; desirable for market.

Dronkane. A late-shipping table grape of excellent quality; berries metallic red, firm, excellent flavor; bunches large.

Emperor. Berries dull-purple, large, firm, very good quality; excellent shipper; vines strong, vigorous, productive. Suited to interior portions of California but not to the Coast.

Feher Szagos. Berries large, dull-green, juicy, meaty, sweet, of best quality. Clusters large to medium, a very good raisin and table grape.

Ferrara. A black grape, flesh of rather poor texture; thick skin, somewhat inferior flavor; bunches and berries large; useful for local sale and long distance shipment.

FLAME TOKAY or Tokay. The leading shipping grape of the Pacific coast; bunches very large, sometimes 8 to 10 pounds in weight; berries very large, red; skin thick; flesh firm, of moderate quality; vines very vigorous.

Gros Colman. Berries dark-blue, very large, thick tender skins which crack when ripe, desirable for local markets. Vine strong grower, very productive.

Gros Guillaume. A black table grape with very large berries of best flavor; bunches medium size; fruit keeps well.

Lignan Blanc. An early yellowish-green grape; while not of high quality is one of the best earlies.

Malaga. Berries yellowish-green, thick skin; flesh firm, good quality, bunches very large; vines strong growers. A good table and raisin grape, good shipper.

Mission. Berries medium size, dark-purple, skin thin; flesh juicy, very sweet, delicious; bunch medium size; vines vigorous, productive; a very good table grape, for local consumption.

Muscat Hamburg. Berries large, dark purplish-red; very juicy, tender, vinous, sweet, rich, very good to best. Clusters very large; good keeper, excellent table grape both West and East.

Rosaki. Resembles Malaga. Berries large, pale yellow-green; very good table grape West and East.

Rose of Peru. Berries large, round, black; skin thin, tender; flesh firm, sweet, best quality; vines very vigorous, productive, excellent for home use and local market.

Sultana. Berries golden yellow, small, round, firm, sweet, good quality. Bunches large. Grown for home use and raisins.

SULTANINA, Thompson Seedless. One of the most popular seedless grapes grown on the Pacific coast; bunches large; berries medium to small with thick skins, golden-yellow color; flesh firm, crisp, juicy, very good quality; vines very vigorous.

Verdal. Berries greenish-yellow, very large with thick but tender skins; crisp juicy flesh; bunches large; vines hardy, medium vigor. A prominent late Pacific Coast variety for local market.

White Cornichon. It is like the purple except in color of skin, also the skin is more tender, rendering it better for table use, but poor for shipping.

KAKI: JAPANESE PERSIMMONS

(In Part After Florida Agricultural Experiment Station)

Light Flesh Varieties

Costata. Tree upright, tall; fruit conical, pointed; size medium to large; color reddish, deep-red with purple bloom when fully ripe; skin smooth, tough, very thin; flesh firm, heavy, granular, color whitish-yellow, brownish in vacant seed cavities; seeds few, one or two, long oval, large. October in Florida.

Dia Dia Maru. Tree thrifty, open, with distinct light foliage; fruit medium size, flat, four-sided; flesh creamy white; quality good to very good.

Fuyu (Fuyugaki). Tree vigorous, upright; fruit medium to large, nearly round but somewhat flattened; skin smooth, tough, reddish-yellow; flesh meaty, very good flavor, astringent until quite ripe. Bears young.

Hachiya. Tree large, spreading; fruit firm, oblate slightly pointed; size very large; reddish-yellow, bright-red at the apex; skin smooth, medium thick; flesh astringent until thoroughly ripe, firm, granular, creamy-yellow in color; seeds one, often seedless. October 15 to 30 in Florida.

Phelps. Fruit small, lemon-yellow becoming reddish. Season October. One of the light-fleshed varieties that have seeds.

Tamopan. In Japan is considered one of the best; tree a thrifty grower; fruit bright orange-red; skin thick, tough; flesh light-colored, seedless; of excellent quality. Some without astringency can be eaten while hard.

Tanenashi. (Seedless). Tree medium size, strongly upright, tops little spreading, productive; fruit round, slightly pointed, large size, skin light-red, leathery, thin; flesh solid, somewhat granular, light-yellow; seeds none. October in Florida. The most popular. Can pollenize itself.

Triumph. Tree medium size, upright-spreading, somewhat compact, very prolific; fruit strongly oblate, slightly four-sided, small, reddish-yellow; skin smooth, medium thick; flesh firm, slightly yellow, dark about the seeds; seeds six or seven. October in Florida.

Tsuru. Upright-spreading tree, medium large, very prolific, light flesh variety, but has seeds; fruit conical, pointed, medium size; skin yellowish-red to very dark-red as it matures, with heavy purple bloom, rough; flesh granular, solid, dark-yellow; seeds three, rather long. Middle of October to middle of November in Florida. Latest of all to ripen its fruit.

DARK FLESH VARIETIES:

Hyakume. Tree upright-spreading, prolific; fruit somewhat spherical, apex flattened, medium size, light-red; skin smooth, very thick; flesh sweet, solid, dark, filled with brownish black specks; seeds 6, slightly kidney-shaped, large. October. Desirable for market.

Miyotan. Tree moderate grower, productive; fruit oblong, slightly pointed, small to medium dull-red; skin puckery, leathery, thick; flesh firm, dark, except a thin layer beneath the skin and about the seeds; seeds 5 or 6. Is edible before it softens. November.

Yedoichi. Tree medium size, open, with drooping branches; fruit roundish oblate, slightly pointed, medium size; skin light-red, covered with dark dots, smooth, medium thick; flesh sweet, granular, yellowish-white; seeds oval, slightly pointed, large; has a tendency to seedlessness. October 15-November 15. Edible while hard.

Zenji. Tree large, upright-spreading, productive, one of the earliest, fruits ripening over a season of two months; fruit roundish oblate, small; skin leathery, very thick; flesh compact, dark throughout; seeds generally eight, slightly kidney-shaped or triangular, dark-brown. October in Florida.

Gailey. Planted as a pollenizer, one plant to seven or eight.

MIXED FLESH VARIETIES

Godbey. One of the hardiest; fruit oblate, yellowish-red; skin smooth, very thin; flesh sweet, compact, granular, mixed color; seeds five, oval. October 15 to November 1.

Okame. Tree medium-sized, compact grower, upright-spreading, reported as a shy bearer; fruit round or oblate, large dark-yellow; skin smooth, medium thick; flesh solid, stringy, light-yellow in color, dark about the seeds; seeds variable in number. Tendency to seedlessness. October. Fruit is handsome in appearance.

Taber 23. Tree small, spreading; fruit strongly oblate, slightly four-sided, small; skin light-red, smooth and stipple-marked and rather thick; flesh sweet, stringy, dark in color with innumerable brown-black specks; seeds six or eight. September to October.

Taber 129. Tree upright, regular and heavy bearer; one of the best very early shipping varieties; fruit oblate, slightly four-sided, medium size, yellowish-red with a few black specks on the surface; skin smooth, except near the apex, thin; flesh somewhat granular, light-yellow beneath the skin, dark and light mixed, in the center; seeds five. September 15 to October 15.

Yemon. Tree medium size, spreading, productive; fruit oblate, something like a tomato, medium size, dark red with yellowish-red base; skin smooth, slightly resembling leather, thin; flesh very sweet, soft, jelly-like around the seeds and in the seed cavities; light-yellow, near the skin, dark in the center; seeds 4, large. One of the best. A good shipper.

KUMQUATS

Nagami. The first variety introduced into the country in 1850. The plant is thornless, robust in growth and its fruit uniform in size; productive; fruit oblong 1¼ to 1¾ inches long, orange color, few seeds; ripens October on, usually two or three weeks later than Marumi. Grows well on the Cleopatra Mandarin as a stock.

Meiwa. Of more recent introduction. Fruits round, orange-yellow, 1¼ to 1¾ inches. It is prolific and in season earlier than Nagami.

Marumi. Fruits deep-orange, round, 1 to 1¼ inches diameter, few seeds. Season October on throughout the winter; ripens early. The plant has very short, sharp thorns, and is valued as a pot-plant because of its compact symmetrical growth.

LEMONS

Eureka. Fruit oblong, size medium, usually seedless, color lemon-yellow; flavor good to excellent; keeps well; tree half dwarf, fairly free from thorns, early bearer, very prolific, grows somewhat too open, one of the best in California and the leading variety in new plantings.

Ever Bearing. Fruit oval pointed, size medium to large; color yellow; flavor fair; contains many seeds; tree bushy grower, bears all the time, suckers freely, grown in Florida. Not a desirable market variety.

Genoa. Fruit oblong-pointed; size medium; seedless; ripens early; color lemon-yellow; flavor excellent; keeps well; tree dwarf, thornless.

Kennedy. Fruit oval; thin-skinned; nearly seedless.

Lisbon. Fruit oblong; size medium; few-seeded; color lemon-yellow; flavor excellent; ripens unevenly, keeps well; uniform; tree of medium size, vigorous, thorny, prolific, plenty of foliage. Bears one large crop maturing in winter.

Ponderosa. Fruit oblong; size large; seeds numerous; color lemon-yellow; flavor agreeable; resembles a pomelo; is sometimes advertised for pot culture in the north.

Sicily. Fruit oblong; size medium; color light lemon-yellow; flavor good

Villafranca. Fruit oval-oblong; size medium to large; seeds numerous; color lemon-yellow; flavor good; tree good grower, good size, very productive, has few thorns, takes longer to come into bearing than Eureka. The principal variety in Florida.

Rough Lemon. Of doubtful origin. Found wild in Florida. Fruits very rough, of no commercial value. Seeds are gathered for growing seedling stocks, which are of value on very poor sandy and calcareous soils.

Dwarf Chinese. Valuable as a pot-plant. Hardy in Florida.

LIMES

Mexican (West Indian). Fruit small, oblong, wild in Florida and West Indies. Usually grown from seed and the only commercial variety as yet.

Persian. Larger than above, said to be of excellent quality. From Persia.

Rangpur (Mandarin Lime). Resembles a Mandarin orange, juice very acid; quality very good, almost as hardy as the sweet orange. Has easily-removable rind and separable segments. From India. Can be grown where other limes cannot.

Tahiti (Bearss Seedless). Seedless, fruit large size, juicy, very acid; tree large, fairly hardy, productive, relatively early bearer. Hume states that Tahiti is much like Persian.

LOQUATS

Advance. Fruit bright-yellow, pear-shaped, sometimes 3 inches long, grows in large, compact clusters; flesh white, juicy, sweet, excellent quality; three to four seeds; ripens March to June; resistant to blight.

Champagne. Fruit golden-yellow, pear-shaped, large, i.e., 2 inches by 1⅝ inches; flesh soft, juicy, light-colored, flavor very sweet; one of the best if not the best; three to five seeds; skin tough; season April to May; clusters not so compact as those of Advance.

Early Red. Reddish, pear-shaped; with thick, tough skin; whitish flesh, of fair quality; size small, 1 inch to 2 inch; clusters medium size; ripens February to May; the earliest of all.

Tanaka. The largest-fruited Loquat in Japan, egg-shaped, very good quality, but ripens too late in California to be of commercial value.

Thales or Gold Nugget. Large, orange-yellow; skin tough; flesh thick, orange-yellow, juicy, flavor sweet, of fair quality; from two to four seeds; season April to May. Very good shipping variety but lacks quality.

Victor. Large, deep golden-yellow; tough skin; of good quality; recommended for canning, season May to July, too late for California.

MANGO

Amini. Smaller than Paheri, 6-8 ounces. Fruit resembles a small Mulgoba. Flavor very good. Tree productive and somewhat resistant to blight. Earlier than Paheri.

Bennett. A strain of Alphonso. Very high in quality but its dull orange-yellow color is against it. Fruit about one pound. Flesh orange-yellow. Season, July-August.

Cambodiana. This lacks flavor and quality but is productive. Color light-yellow. Flesh yellow, juicy, pleasant, but lacks the richness of Mulgoba. Season Florida, earlier than Mulgoba.

Haden. Resembles Mulgoba, is somewhat larger but not quite so high in flavor.

Mulgoba. On account of its fine flavor, the smoothness and fineness of its pulp, its freedom from fibre, it is regarded as excellent. The fruits are oval, plump, yellow, with scarlet base, and weigh a pound. Season in Florida, July to September. Does not bear early and is somewhat irregular.

Paheri. Excellent quality. Fruit about 12 ounces, oval, plump orange-yellow, with scarlet blush and orange flesh. Rich and spicy. Season, Florida, July-August.

Sandersha. Very large, up to 2 pounds, orange-yellow. Flesh somewhat coarse, but of good flavor. Excellent for cooking. Regular bearer. Ripens late—late August to end September.

MULBERRIES

Downing. Fruit, large, black, sub-acid, very good. Tree, productive, not quite hardy in the Northern states. Usually New American is sold as Downing.

Hicks. Fruits medium size, very sweet, good quality. Tree productive, vigorous grower, fruit ripens over a period of three or four months.

Johnson. Fruit very large, black, often 2 inches in length by ¾ inch; sub-acid, tree strong grower, is apt to be unproductive.

Merritt. Fruit very large, ripens in April and May. Tree bears while young and is a strong grower.

New American. Fruit large, 1 to 2 inches long. Tree hardy, productive, vigorous; fruit ripens from June to September. Usually recommended for Northern states.

Russian. Fruit varies from purplish-black to creamy-white. Some strains are good to eat, others are worthless, but may serve to attract the birds. Tree may be spreading, drooping, hardy. Nursery trees grown from seeds are usually sold as Russian. They are quite variable, some desirable—others not.

Stubbs. Fruit large, 2 inches by ¾ inch, deep black, sub-acid, quality good. Tree very productive, valuable for the South.

Weeping. Fruit, small, whitish, of little value. Tree grown for ornament.

OLIVES

In California, most of the recent plantings consist of Mission, Ascolano, Manzanillo and Sevillano and a few other varieties to a small extent.

Ascolano. The largest of all olives. Fruit oval, shows little color, being known as the ''white olive of Ascoli.'' Flesh very tender, needs special care in pickling to darken the fruit properly and salt in the lye throughout the process of curing. It is productive, and planting is limited by scarcity of trees.

Manzanillo No. 1. Apple-shaped and of Spanish origin. Fruit larger than Mission, ripens several weeks earlier, is deeply colored, bitter when ripe, requiring the use of strong lye, but very careful treatment since the fruit softens easily. The oil from it is said to be somewhat inferior to that of Mission in both quantity and quality.

Manzanillo No. 2. Of excellent quality, but lacks size for California conditions.

Mission. An excellent variety for ripe pickles on account of its deep color when ripe. It does not mature in the cooler sections, requiring a longer growing season. Fruit pointed, small to large, according to the soil it is on, and conditions, but is rated as large; fruit very bitter, firm, easy to pickle. Over half of the olives in California are of this variety.

Macrocarpa and **Polymorpha.** Both possess large size and are suitable for large pickles, but are subject to a disease which causes the fruit to spot and soften. Other large fruiting varieties which have been tried and discarded are Obliza, Salonica, Regalis, Columbella, Empeltre. Nevadillo is highly esteemed for the oil it produces, is quite sensitive to cold and apt to be a shy bearer. The fruit is subject to dry rot.

Sevillano. A typically olive-shaped fruit, larger than Ascolano, but not so uniform; large pit, of deeper color than Mission. Tree productive on rich, warm soils, but its range of adaptation is limited. The largest ''Queen'' olives of Spain are of this variety and it is adapted to making green and ripe pickles of the largest sizes.

ORANGES

There are several distinct types:

Sour, Bitter or Seville Orange (*Citrus aurantium*). This type is found wherever oranges are grown. It now occurs wild in Florida and is used almost exclusively as a stock for other citrus fruits because it is resistant to ''foot rot.'' The sour orange fruit is used for marmalade and orangeade, and in France the flowers are used to make a perfume; the unripe fruits, shoots and flowers make ethereal oil. The tree is of medium size. There are no named varieties in cultivation in the United States. The Bitter Sweet, a hybrid between the sour and the sweet orange is found wild in Florida. Its fruit ripens late, hangs well on the trees. It is sometimes cultivated for home use.

Mandarin or Kid Glove Orange (*Citrus n. deliciosa*). A shrub or small tree which is very sensitive to hot winds. The fruit has a sweet pulp, is easy to peel and this group embraces all the so-called Tangerine oranges. In Florida this type is ready for shipment from the end of September to the middle of April, when owing to the hot weather the fruit loses flavor and is worthless. Some of the varieties are:

Beauty (Beauty of Glen Retreat). Oblate, flattened. December to January.

Mandarin—China, or willow-leaved Mandarin, form oblate compressed; size medium, 2 inches up; color dark-orange, seeds numerous; flavor peculiar; very juicy, sweet. November-December, Florida. January to April, California.

Cleopatra. Small. January to February. Used as a stock for Mandarins.

Dancy (Tangerine). The best of its type. Form oblate; size medium, 2 inches up; color deep-orange, flesh dark-orange; seeds rather numerous, excellent quality. December to January in Florida, January to February and later in California. Tree compactly headed, dense foliage, prolific.

King Orange (*Citrus nobilis*). Form oblate, fruit large with a characteristic rough skin, color deep-orange; quality very good, a delicate vinous flavor. Tree stiff upright grower, medium size, thorny; wood brittle; fruit sometimes scalds on tree. March to April in California.

Kimeloa.

Kino Kuni.

Mikado.

Oneco. Fruit medium to large, orange yellow, midseason.

Satsuma (*Citrus únshiu*). Fruit medium-size, oblate, skin inclined to be rough, orange-yellow; flavor agreeable; quality excellent; generally seedless. October and November (Florida), November to March (California). The fruit is at its best just as it reaches maturity.

Bergamot orange (*C. bergamia*) furnishes the Bergamot oil, which is made from the rind. It is grown in Europe but not to any extent here.

Common Sweet orange includes navels, Florida seedlings, Mediterranean varieties, etc. (*Citrus sinensis*). Tree 20 to 35 feet tall, cultivated throughout the tropics and subtropics. Not as hardy as the Sour Orange, more hardy than the lemon and lime, extensively grown in southern California, Florida, also in parts of Arizona, Louisiana and Texas; 70 varieties are in cultivation, most of them of American origin. Fruit when ripe has sweet, slightly acid pulp, it is eaten raw and is used for marmalade and wines.

Navels. Washington Navel, Bahia, Riverside Navel, the main variety in California, constituting over 60 per cent of the crop. Form rounded, tapering at apex, size large, 2½ inches to 3½ inches; variable; color orange when grown near the coast in California, deeper orange when grown in the interior; flavor excellent; skin ⅛-inch to ¼-inch thick, smooth to pebbly; secondary orange under the navel variable, often ¾-inch in diameter; good shipper, seeds few or none. Southern California, January to May. Arizona North and Central California middle of November to middle of January. It does not succeed in Florida. Tree semi-dwarf, early bearer, vigorous, practically thornless. The higher quality fruits are grown on gravelly soils of the foothills in the interior valleys of California. June drop is a problem on such. Heavier yields are secured near the coast. The variety shows a marked tendency to produce bud sports which are new varieties. Some of these are Australian, Buckeye, Navelencia, Nugget, Thomson.

Australian. A rank-growing, rough-fruiting, shy-bearing sport of Washington Navel. Sometimes used to designate any worthless navel orange.

Buckeye. Size medium; skin smooth; season early; sport of the Washington navel orange.

Double (Imperial). Said to do well in Florida when budded on Trifoliate stock.

Mèlitensis. Sometimes grown in Florida.

Navelencia. Size medium to large, skin smooth, thin; later than Washington, more easily injured by frost.

Nugget.

Thomson. Size medium; skin thin, smooth; quality inferior to Washington Navel of which it is a sport. Being superior in appearance it often outsells Washington Navel in markets where appearance is a prime requisite. Season with Washington.

Surprise. Form rounded; size medium; color deep-orange; skin smooth tough; flavor rich; quality excellent; seeds none; November to February

(Florida). Is recommended as a suitable navel for trial in Florida where Washington Navel is not profitable.

Sustain. Sometimes grown in Florida.

Varieties suggested for interior dry valleys of California where Washington Navel is subject to June drop are Boone Early, Enterprise, Pineapple, Indian River, Bessie.

FLORIDA VARIETIES:

Acme. Form oblate, size medium to large; flavor rich; quality very good; seeds fourteen; December to January (Florida).

Arcadia.

Boone (Boone's Early, Giddings). Form rounded; size medium; color deep-yellow; rind smooth; flavor very good, very juicy, seeds twenty-five. Early September to October. Some report this variety as very late and as hanging well on the tree.

Drake Star.

Dummitt. Form slightly oblate, size large; color light-orange; rind thin; flavor fairly good; quality medium; seeds fourteen; December to February.

Early Oblong (St. Michael's Egg). Form oblong; size medium to large; color yellow to orange; rind smooth; flavor sweet, good; seeds 22. September to October.

Enterprise (Enterprise Seedless). Seedless; form roundish, oblong; size large; color orange; rind pitted; average thickness; flavor rich; quality very good; seeds six. October to November.

Foster. Medium to large; rich flavor; excellent quality; 13 seeds. October to November.

Hick (Hick's Sweet Seville).

Homosassa. Form slightly oblate; size medium to large; color yellow to orange; rind thin, tough, smooth; flavor rich; quality excellent; good keeper; seeds 20 to 24. December to February. Tree nearly thornless, productive.

Indian River.

Lue (Lue Gim Gong). Fruit oval, juicy, very late, hold well on tree until late summer; believed to be Valencia.

Madam Vinous. Fruit medium to large; pulp coarse grained; juicy, midseason.

Magnum Bonum.

May (Dr. May's Best).

Nonpareil. Fruit rather large, flat; pulp fine-grained, juicy, tree vigorous.

Old Vini.

Osceola.

Parson Brown. Form rounded; size medium to large; color yellow to orange; seeds small, ten to nineteen; October to November. Needs picking early or loses flavor.

Stark.

Whittaker.

MEDITERRANEAN VARIETIES:

Bessie.

Centennial. Form round; size small to medium; color orange; rind smooth, thin; flavor rich, vinous; quality excellent; seeds about ten; November to December. Although the fruit ripens early it can be held late.

Circassian. Form rounded; size medium to large; color light-yellow; rind thin, very smooth; flavor very good; seeds 10 to 21; December to February.

Du Roi. Form oblong, size medium to large; color yellow to deep-orange when ripe; flavor rich; quality excellent; seeds about 14; February to March.

Exquisite.

Everbearing.

Jaffa. Form rounded oblate; size medium to large; color orange-yellow to orange-red; rind smooth, thin, leathery; flavor rich; quality excellent; seeds few to numerous. December to February (Florida), March to May (California). Tree medium-size, almost thornless, resistant to cold.

Joppa. Form oblong; size medium; color orange; rind somewhat rough, medium; flavor good; quality fairly good; seeds few. January to March (Florida), March to July (California). Tree large, thornless.

Mediterranean Sweet. Form round, size medium to small; color deep-orange; rind thin; flavor sweet, very good; April to June (California). Tree semi-dwarf, thick foliage, almost thornless.

Majorca. Form slightly oblate; size small to medium; color orange; rind smooth, thin, tough; flavor rich, vinous; seeds few, five or six. February to March (Florida).

Maltese Oval.

Marquis.

Paper Rind (Paper Rind St. Michael). Form round, size medium, very solid; color orange; rind very thin, smooth; flavor rich, quality excellent; seeds six; February to March (Florida). March to May (California). Tree semi-dwarf, medium thorny, very productive.

Pineapple. Medium to large, very juicy, seeds rather numerous. Tree strong grower.

Prata (Silver).

Valencia (Valencia Late, Hart, Hart's Late, Hart's Tardiff, Excelsior). Form round or slightly oval; size medium to large; color deep golden-orange; rind thin, smooth, tough; flavor rich, vinous; quality excellent; seeds few, six. Fruit solid, heavy, good shipper. March to June (Florida and North and Central California); June to December (Southern California). Tree large, vigorous grower, few small thorns, prolific, bears early. Fruit hangs well, but in interior valleys of California is apt to turn green if left too long on the tree. Being so late it has little competition. It is the second variety in importance in California, furnishing about one-third of the crop, Washington Navel being in the lead.

White.

MEDITERRANEAN BLOOD ORANGES:

Maltese. Form round or slightly oblong; size medium; often seedless; skin very smooth, thin, tough; very juicy, sweet, sprightly; good shipper; December to April (Florida). Tree vigorous, nearly thornless, prolific.

Ruby. Form round or slightly oblong; size variable, small to large; color yellow to orange; red when ripe; rind smooth, shiny, thin; flavor rich; quality excellent; seeds few, eleven to many. February to March (Florida), March to April (California). "Has few equals and no superior." Tree medium size, almost thornless, compact grower.

St. Michael. Form oblong rounded; size medium; color yellow with red blotches when ripe; rind thin; flavor excellent; seeds present; January to February (Florida).

Sanford.

Saul Blood.

PEACHES

Admiral Dewey. Very early, freestone, suitable for home use only.

Albright Cling. Large, late, yellow, canning peach. Good shipper, very good quality.

Alton. Early midseason white-fleshed, semi-free, quite subject to leaf curl. Fruit quite variable in size, moderately productive.

Angel. A peento type, white flesh freestone. Good quality; blooms late. Suitable for South.

Arp. One of the earliest good yellow peaches. Hardier in bud than the average. Flesh light yellow, firm, juicy, sweet, excellent quality, somewhat apt to cling to the stone; quite susceptible to brown rot; sometimes sold as June Elberta.

Belle (Belle of Georgia) an excellent white peach. In season just before Elberta. Trees are open-headed, somewhat straggling, hardy, subject to leaf curl; do very well in the Southern states; one of the commercial peaches, desirable for home use.

Berenice. White, midseason, excellent quality, somewhat subject to leaf curl, not quite as productive as it should be.

Bilyeu. A white, large freestone, suitable for local market in California.

Brackett. A yellow freestone ripening after Elberta. Suitable to the South.

Captain Ede. White, good-shipping peach, ripening with early Crawford, a week or ten days ahead of Elberta. Trees productive, crop fairly uniform. Somewhat fastidious as to soil, doing best in the South.

Carman. A useful white, early peach, good quality. Tree quite hardy; the variety is grown over a considerable area; apt to overbear, needs thinning. Must be picked while firm, if it is to be shipped. Commercial.

Chairs. A desirable, good quality yellow freestone. Home use.

Champion. One of the highest-quality white-fleshed peaches, quite fastidious as to soils. Tree vigorous, hardy, fruit excellent for home use, not a good shipper.

Climax. White, freestone peach, regarded with favor in the South. Is commercial in Florida.

Connet. White, early, midseason, nearly freestone, ripens with or after Carman. Excellent for local market and home use.

Crosby. Yellow freestone, excellent quality; fruit small, irregular in size. Tree is notably hardy in bud, being similar in this respect to Chili, Smock, Heath Cling.

Early Crawford. Once the standard yellow-fleshed peach, but lacking productiveness, it has been retired. Fruit large, yellow, handsome, needs suitable soil to do well.

Edgemont. Resembles Late Crawford, but is more productive; high in quality for home use.

Elberta. The leading commercial peach. Is grown on all soil types, productive, withstands most insect and fungus troubles and generally succeeds in arriving at destination intact. The tree lacks hardiness in wood and blossom; fruits are somewhat short in quality. Yellow, freestone.

Engle. Resembles Late Crawford, ripens a little earlier, is usually more productive.

Eureka. A southern early white-fleshed, semi-free peach.

Fitzgerald. Resembles Early Crawford, but is probably a little more productive, ripens a little earlier.

Florida Gem. A white freestone, early peach for the South.

Foster. Resembles Late Crawford, somewhat larger, not quite as productive.

Fox. A white freestone, good quality, for the South.

Frances. Yellow freestone, rich flavor, good quality, follows Elberta.

Gold Drop. A late, hardy, yellow peach. In flavor in Michigan; is resistant to brown rot and leaf curl, productive. Valuable for home use where a hardy peach is required.

Greensboro. An early white-fleshed peach. Apt to overbear; semi-cling.

Heath Cling. The oldest-named American peach, white, excellent for preserves and pickling.

Hiley. The earliest commercial freestone white-fleshed peach, ripens before Belle; fruits quite subject to brown rot. Does better in the South than in the North.

Honey. White-fleshed, freestone peach, suited to the Gulf Coast states, reproduced from seed.

Illinois. Midseason, white-fleshed freestone peach, ripens with Champion. For home use only.

Imperial. A white freestone, honey peach. South.

Iron Mountain. A very late, white freestone peach, quite hardy, grown in New Jersey.

J. H. Hale. Resembles Elberta, usually not as productive; the fruit is firm, appears to ship better; ripens a little earlier and is reported as somewhat hardier than Elberta. Needs a pollenizer.

Jewell. Medium-size light-yellow freestone, early. Suitable for Central and South Florida.

Kalamazoo. Yellow-fleshed freestone, better quality than Elberta, but not so showy. Ripens with Late Crawford; tree hardier in bud and wood; susceptible to leaf curl. Fruit of excellent quality, but somewhat small.

Krummel. Regarded as one of the best very late yellow freestones. Planted in the Central Atlantic states.

Late Crawford. Tree vigorous, hardy, healthy, but unproductive and tardy in coming into bearing when compared with Elberta. Fruit well known for its rich flavor. Matures after Elberta. Home use.

Lemon Cling. Popular in California as a canning peach. Flesh deep, lemon color, agreeably acid. Very good when fully ripe.

Lemon Free. Yellow-fleshed freestone, late midseason; quality very good, flavor sweet, excellent for canning, grown in California.

Lola. White peach, ripens with Carman, well adapted to the South. Is hardier in bud than Carman.

Lovell. Yellow freestone, medium-size, largely grown in California for canning, drying and shipping.

McDevitt Cling. An excellent yellow-fleshed highly-flavored canning and shipping clingstone in California. Late.

McKevitt Cling. A highly prized white-fleshed, highly flavored canning and shipping clingstone in California. Grown for home use also.

Mamie Ross. White-fleshed midseason handsome peach, flesh somewhat coarse, easily injured; regarded favorably as a market peach in Texas and other parts of the South.

Matthews. Yellow-fleshed freestone, ripens after Elberta, suitable for New Jersey to Maryland.

Mayflower. Early white clingstone. Suitable for South.

Muir. Late-midseason, yellow-fleshed freestone peach, excellent for canning in California; tree vigorous, productive, relatively free from leaf curl.

Niagara. A seedling of one of the Crawfords. Ripens later than early Crawford, is larger, not productive.

Orange Cling. Skin deep-orange, flesh dark-yellow, firm, juicy, sometimes grown in California.

Pallas. One of the best of the honey-flavored beaked peaches. Tree vigorous, hardy; fruit subject to brown-rot, does not ship well, excellent for home use in Southern states.

Peento. Flat cling. Suitable for extreme South.

Phillips Cling. Perhaps the most popular yellow-fleshed clingstone in California.

Ray. White freestone, ripens with Belle.

Red Bird Cling. Very early, white clingstone; suited to Southwest.

Rochester. Early yellow freestone, or semi-cling; ripens ahead of Early Crawford; is apt to overbear and needs thinning; hardy; a promising early peach. Subject to brown rot.

Salwey. Yellow--fleshed freestone late peach of good quality; not handsome in appearance; excellent for canning, preserving and evaporating. Tree hardy, healthy and productive. Needs long season.

Sellers Cling. One of the best midseason yellow-fleshed clingstone canning peaches in California. Very productive.

Slappey. Medium-sized yellow-fleshed freestone; good quality, grown in the South. Ripens last of June in Alabama or ahead of Elberta.

Smock. Late yellow peach, but there are others better.

Stevens. Large, white-fleshed freestone; very good quality, hardy in wood and bud. For home use.

Thurber. White-fleshed midseason freestone, adapted to the South. For home use or nearby market.

Tuskena, Tuscan Cling. One of the best early yellow-fleshed clingstones for canning and shipping in California.

Waddell. Early midseason white-fleshed semi-cling. Competes with Carman, which seems to have distanced it.

Wager. Yellow-fleshed freestone, excellent for canning, drying and culinary purposes. Fruits not attractive, small. Trees hardy, productive, bear early. Good for home use where a hardy tree is required.

PEARS

Ansault. An excellent pear for home use, rivals Seckel in quality.

BARTLETT. This is the leading variety in America, being grown in all the commercial pear sections from New York to California. It is the leading variety for canning. Tree an upright grower, thrifty, yellowish-brown shoots; fruit large, stem 1¼ inches long, stout; skin thin, smooth, clear-yellow with a blush on the sunny side, sometimes faintly russet; flesh white, fine grained, juicy, sweet, very good. End of August to end of September. Can be held in storage until November.

Belle Lucrative. A small fall pear of excellent quality, suitable for home use.

Beurré d'Anjou (trade name Anjou). Tree hardy, upright, large vigorous, strong grower, shoots yellowish-brown; fruit large, obovate, sometimes nearly globular; stem short, thick, fleshy; skin greenish, sprinkled with russet, sometimes shaded to dull-crimson; flesh whitish, somewhat coarse, juicy, rich flavor, very good. November. Can be held in storage until February. In some places it is regarded as a shy bearer and the fruit drops readily.

Beurré d'Arenberg. An excellent winter pear for the pear-growing regions on the Pacific Coast. Does not mature in the East.

Beurré Bosc (Bosc). Tree upright-spreading, vigorous shoots, long, willowy brownish-olive; fruit large, pyriform, tapering long and gradually into the stalk, its striking shape makes it readily recognized; stem long, 1 to 2 inches, slender, curved; skin dark-yellow, streaked or dotted with cinnamon russet; flesh yellowish-white, melting, buttery, delicious, very juicy, slightly perfumed, very good to best. Fruits hang singly. Tree not apt to overload; slow in coming into bearing. Good commercial variety and excellent for home use.

Beurré Clairgeau (Clairgeau). Tree vigorous, pyramidal, productive, young wood reddish-brown; fruit large, pyriform, with unequal sides; stem very short, stout, fleshy; skin yellow to fawn, shaded with crimson, thickly covered with russet dots, sometimes sprinkled with russet; flesh white, buttery, juicy, somewhat granular, perfumed, vinous flavor, often of but fair quality. October to January. As a winter pear, this is finding favor on account of its size, its tendency to bear early and its productiveness. It is apt to drop.

Beurré Giffard (Giffard). Tree moderate grower, with reddish-colored shoots; fruit above medium in size; stem medium in length; skin greenish-yellow, red on the sunny side; flesh white, melting, juicy, very good. Season middle of August. A good early pear.

Beurré Hardy (Hardy). Tree vigorous grower, does well on both pear and quince; fruit large, obovate, pyriform; stem 1 inch long; skin greenish, with light-russet or brownish red shading; flesh buttery, melting, juicy, vinous, highly perfumed, very good. Season September, October.

Beurré Superfin (Superfin). Tree vigorous grower, young wood fawn-colored; fruit medium, oblate; stem stout, rather long, variable; skin yellow, shaded with crimson on the sunny side, sometimes covered with russet; flesh very juicy, buttery, melting, brisk sub-acid flavor. October.

Bloodgood. A high-flavored early pear of value for home use.

Buffum. Sometimes grown for orchard use. Variable in quality, fruit medium-size.

Cayuga. A Seckel seedling. Fruit as large as Bartlett. Quality very good. Season September. Originated by Geneva (N. Y.) Agricultural Experiment Station.

Clapp Favorite. Tree vigorous, productive; young wood purple; fruit large, with a large body, tapering to a rather small neck; stem short, stout; skin smooth, yellowish-green turning yellow, with a red cheek; flesh greenish- or yellowish-white, juicy, melting, perfumed, of very good quality. Season just ahead of Bartlett. Tree quite subject to fire blight. Fruit must be picked before fully ripe, otherwise it will be found to be decayed at the core. Grows well over a large area.

Comice. Tree vigorous, upright; fruit large, pyriform; stem medium, curved; skin yellow with reddish cheek, inclined to russet, with russet dots; flesh yellow, juicy, buttery, rich, vinous flavor. October to November. Later in cold storage. This variety is finding favor in the Western states. It is a good shipper.

Dana Hovey. A winter pear resembling Seckel. Excellent for home use.

Doyenné Boussock. Tree vigorous, early and productive bearer; fruit large, variable, obovate, conic; stem short, stout; skin smooth, pale-yellow to russet; flesh white, juicy, good. Season September, October.

Duchesse d'Angoulême or **Duchess.** This variety is usually grown on the quince. It is held that it is better adapted to this root than to pear root. Tree slow grower, upright, young wood yellowish-brown; fruit very large, oblong obovate, with an uneven somewhat knobby surface; stem 1 to 2 inches long, curved; skin dull greenish-yellow, streaked and spotted with russet; flesh white, buttery, juicy, rich, very good when properly ripened and well grown. October to November. On standard trees, the fruit is not of the highest quality. Is not making headway commercially.

Easter Beurré. Tree upright, strong grower with reddish-yellow shoots; fruit large, roundish obovate; stem short, stout; skin thick, yellowish-green with russet dots, somewhat brownish cheek sometimes; flesh yellow-tinged, fine-grain, buttery, juicy, sweet rich flavor, very good. December to February. One of the best winter or spring pears if grown where the season is long enough for it to develop properly. It does better in the West than in the Eastern states. Is fastidious as to soil and climatic requirements, requires warm, rich soil.

Elizabeth. A very good early dessert pear. Very sweet and with a peculiar flavor. Good for home use. Tree moderate grower, shoots reddish with red and brown dots; fruit below medium-size, obovate; stem 1 inch long; skin bright-yellow with red cheek; flesh whitish, juicy, sprightly, very good. August.

Flemish Beauty. Tree strong grower, early and abundant bearer; shoots dark-brown; fruit large, obovate; stem medium, thick; with somewhat rough skin, pale-yellow, light-russet to reddish-brown covering; flesh yellowish-white, juicy, sweet, rich, needs to be harvested early and when properly ripened has good flavor; if ripened on the tree it is worthless. End of September. Needs careful spraying to protect it.

Garber. Tree upright, not unlike Kieffer; fruit large; stem ¾ to 1 inch; skin yellow when mature, with crimson cheek; flesh similar to Kieffer. October. Of value for the South, and for canning. Used as a pollenizer for Kieffer.

Glou Morceau. One of the best of our winter pears that has not made any headway commercially. Tree spreading, vigorous; fruit large, variable in form, usually obtuse-oval; stem 1 inch, curved; skin thin, pale greenish-yellow, with patches of russet; flesh yellowish-white, fine grain, smooth, rich sugary flavor, apt to be astringent. December, later in storage. In suitable climate, it is an excellent cropper, entitled to a place in the home garden. Does well on quince root and on heavy soils.

Gorham. New. Originated by Geneva (N. Y.) Agr. Exp. Station. A late Bartlett.

Howell. Tree vigorous, spreading, early bearer and regular; fruit medium, oval; stem 1 inch, stout; skin light waxen-yellow with finely shaded somewhat russet cheek; flesh yellowish-white, rather coarse, granular, rich, but quite variable. September to October. Fruits not of good quality.

Josephine de Malines. Tree vigorous, hardy, productive; fruit medium, somewhat flattened in shape; stem long; skin yellowish, sprinkled with russet; flesh buttery, juicy, perfumed, good quality; November to February. Suitable for the home orchard.

Kieffer. Tree vigorous, productive, upright, branches tend to grow rapidly willowy, and if unpruned, bear down to the ground; fruit medium to large, oval, narrowing toward both ends; stem 1 inch long; skin yellow sometimes with handsome red cheek, thick, tough; flesh usually coarse, juicy, fair to poor; quality, unless properly ripened, is low. It should be held in a dark place and allowed to develop flavor. In many sections it needs a pollenizer. It is not of good enough quality for dessert, but is satisfactory for canning and is one of the most common market varieties. October to November.

Koonce. Tree vigorous, upright grower; fruit medium size; stem 1 inch to 1½ inches long, medium stout; skin greenish-yellow, sometimes with a bronze cheek; flesh whitish, juicy, good quality. August. Tardy in coming into bearing.

Lawrence. Tree moderate grower, hardy, productive; fruit medium size, obovate; stem medium to long; skin thick, lemon-yellow with minute brown dots; flesh yellowish-white, somewhat granular, rich, very good. November to January or later in storage. A very good early winter pear for the home orchard.

Le Conte. Tree distinctively upright, not unlike Kieffer and Garber; fruit medium to large in size; stem medium length, rather stout; skin yellow; flesh similar to Kieffer in quality, or poorer. Ripens ahead of Kieffer. Used as a pollenizer for Kieffer.

Lincoln. Valuable in the Middle West. Often mediocre in quality. Tree hardy, vigorous, very productive; fruit medium size; stem 1⅛ inches, slender; skin thick, rough; greenish-yellow, with russet; flesh yellowish tinge, coarse, granular. August to September.

Louis Bonne de Jersey. Tree vigorous, upright, productive, does well on quince stock; fruit large, pyriform; stem about 1 inch long, curved; skin smooth, pale yellow with brownish-red on the sunny side; flesh yellowish-white, very juicy, melting, rich, very good. September to October.

Lucy Duke. This appears to be a cross of Bartlett and Winter Nelis. The fruit somewhat resembles a Bartlett of medium size, of a beautiful russet color. The tree originated in North Carolina. It has been claimed to be relatively immune to blight, and is regarded as not far behind Seckel in quality. Tree medium-size, lacking in vigor, upright, slightly spreading; fruit medium size; stem short, thick, slightly curved; skin medium thick, tough, rough, deep dark-russet, changing to golden-russet; flesh yellowish-white, fine grained, mildly juicy, rich, sweet, very good. October to early November.

Marie Louise. Tree medium-size, hardy, spreading; fruit large, oblong, pyriform, somewhat one-sided, is more highly appreciated in Europe than here; stem 1⅛ inches, curved; skin pale-green, turning rich-yellow with light russet; flesh yellowish-white, rich, buttery, very good. September to October.

Passe Colmar. Tree vigorous, upright, productive; fruit medium size, obovate; stem 1 inch long, very thick; skin thick, pale green, turning yellowish; flesh yellowish, granular, very juicy and melting when ripe, very good. December to January. Trees are apt to overbear. Need thinning. Undersized fruits are worthless in quality. Needs a light, warm soil.

P. Barry. One of the best winter pears and grown in California where it is supplanting Winter Nelis to some extent. Tree a poor grower, said to do better if budded on another variety; fruit large, long; stem 1 inch, curved; skin orange-yellow, with russet dots and blotches; flesh juicy, buttery, rich, of good quality. Late winter.

Pineapple. Is stated to be blight resistant and of value for the Southern States.

Rutter. An excellent late autumn pear, large size.

***SECKEL.** The standard of excellence. Tree hardy, one of the healthiest of all, forms a compact, symmetrical head, upright-spreading, olive-colored wood; fruit small, obovate; stem ½-inch to ¾-inch long; skin brownish-green at first, becoming dull yellowish-brown with reddish-cheek; flesh whitish, buttery, very juicy, melting, rich, spicy. End of August to October.

Sheldon. Tree vigorous, upright-spreading, hardy, good bearer; fruit medium or above medium, roundish, conic; stem short; skin yellow or greenish-russet; flesh little coarse, melting, juicy, very good. October. Very good for home use.

Tyson. Tree upright, vigorous, somewhat tardy in bearing but productive; fruit medium but variable in form; stem long, curved; skin deep yellow, slightly russet with crimson cheek; flesh fine, juicy, melting, sugary, very good. Except in size and color of the fruit it is a better pear than Clapp Favorite; both have the same season. August to September.

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* Leading commercial varieties.

Urbaniste. One of the finest fruits for home use, ripening in October. Best grown as a dwarf. November.

Vermont Beauty. Almost equal to Seckel in flavor and ripens later and keeps better. An excellent pear. Tree vigorous, upright-spreading, hardy; fruit medium size; stem ¾ inch, curved; skin thick, smooth, lemon-yellow with a blushed cheek; flesh yellowish tinge, very juicy, rich, very good. October to November.

Vicar of Winkfield. Tree vigorous, upright-spreading, hardy, productive; fruit large, oblong, pyriform; stem 1½ inches, slender, curved; skin thick, smooth, pale-yellow, sometimes with brownish cheek with small brown dots; flesh white, when well grown juicy, buttery, sprightly flavored. December to January. Needs a warm climate and under suitable conditions is productive, hardy. On account of its fine size, it may be profitable.

White Doyenné (Virgalieu). Tree upright, strong grower, yellowish-gray or light-brown shoots; fruit medium, quite variable; stem medium to fairly long; skin smooth, clear pale-yellow, often with red cheek; flesh yellowish-white, fine grained, buttery, rich. September to December. An old favorite for home use.

Wilder Early. A large, pale-yellow, very good summer pear. Suitable for home use or nearby market.

Winter Nelis. Tree hardy, medium size and vigor, spreading, regular bearer; fruit medium to small, roundish obovate; stem long, 1½ inches; skin yellowish-green dotted with gray-russet, covered with russet patches and streaks; flesh yellowish-white, fine grain, juicy, rich, very good. December to January in common storage, later in cold. Quite subject to scab; needs thorough spraying, good cultivation. Otherwise it is too small and worthless.

Worden Seckel. The fruit is larger than Seckel and keeps better and comes in with it. Tree very hardy, comes into bearing early, vigorous, productive; fruit medium size; stem ¾ inch, thick; skin thin, golden-yellow with blush on exposed side; flesh very juicy, tender, melting, very good. September to October.

PERSIMMONS

Boone. Season October to November. Size, medium; yellow, rather tough skin, many seeds, sweet flavor, good quality.

Burrier. Season early. Size, medium; yellow skin, almost seedless. Soft, very good quality flesh.

Delmas. Season October to November. Size, medium to large; reddish-yellow. Seeds, numerous. Quality very good.

Early Golden. Ripens in September in Illinois; medium to large, yellow; quality very good.

Golden Gem. Season, August to October. Size, medium to large, dark-orange to red skin, quality good.

Hicks. Season, October; size medium to large; dark-red, very good quality.

Josephine (Honey). Season, September in Missouri; size large; bright-yellow, quality good.

Kansas. Season, September in Missouri; size large; yellow splashed with red; quality very good.

Ruby. September on; small to medium size; yellowish-red to deep-red, very good.

Shoto. October; size large; dull-yellow; few seeds, very good.

Sweech. Season, October to November in Pennsylvania; dull-yellow splashed with red; very good.

PINEAPPLES

QUEEN GROUP

Abachi. Size variable, specimens 4 to 6 pounds, 9 by 5 inches long, oblong, color deep-yellow; eyes medium size, somewhat circular in shape, flat. Flesh yellowish, flavor rich, sweet, juicy, one of the best. Season June to September. Desirable for home use. Frequently a poor shipper.

Black Ripley. Size medium, 2 to 5 pounds, 5½ by 4⅛ inches, oblong to conical, color orange-yellow; eyes prominent, small, rectangular in outline. Flesh creamy-yellow, sweet, rich, juicy, quality excellent. Before ripening, this variety has a black-green color, hence the name. Not commercial.

Cayenne. Size large, 5 to 8 pounds, 7¾ by 5⅝ to 8x5¼, oblong tapering slightly. Yellow color. Eyes broad, flat. Flesh firm, yellowish, juicy, rich, sweet. One of the best of the fancy pineapples. Grown in Hawaii, the Azores and under sheds in Florida.

Egyptian. Size medium, 2 to 4 pounds, oblong tapering somewhat. Color deep-yellow. Flesh yellow, sweet, excellent flavor, juicy. Grown in a small way.

Enville. Has been almost entirely discarded.

Golden. Grown principally in sheds. Fruit is of excellent quality, size large 4 to 8 pounds. Form oblong, tapering. Color deep-yellow, eyes prominent, somewhat conical shaped. Flesh deep-yellow, juicy, free from fibre.

Green Ripley. Fruit is sweet, excellent quality.

Pernambuco. The standard in quality among pineapples. Size small, 1 to 3 pounds, form oblong sloping to the crown; eyes roundish with the lower portion rectangular; flesh yellow, juicy, rich flavor, excellent quality. Season July to August.

SPANISH GROUP

Porto Rico. Size very large; sometimes as much as 12 to 15 pounds, 9½x6½ to 12x6¼ form broad at the base, sides sloping upward. Color yellow to dark-green before ripening. Eyes irregularly rectangular, broad, flat; flesh yellowish-white, very fibrous, sweet flavor, juicy, only fair quality. Its handsome appearance makes it valuable for decorative purposes. The fibre it contains is against it.

Spanish, Red Spanish. Ninety-five per cent of the Florida plantings are of this type. Healthy, vigorous, desirable for field culture. Size, medium, 2 to 5 pounds, 5¾x4⅝ to 5¼x4⅛. Form oblong, somewhat sloping. Color yellow, sometimes distinctly reddish. Eyes somewhat rectangular, flat; flesh white, comparatively free from fibre; sweet, mingled with acid. Juicy, good quality. Season, June to August.

PLUM

D—Domestica. J—Japanese. N—Native.

Abundance. (J.) (Botan, Babcock, Botankio, Case, Yellow Japan, Douglas, Oriole, Burbank No. 2.) Tree large, vigorous, open-topped, hardy, very productive, subject to shot-hole fungus, season early; fruit moderate size, roundish, pinkish-red to dark-red; flesh yellow, juicy, tender, sweet except next to the pit; subject to brown-rot; matures unevenly; drops readily; must be picked before it is ripe; adaptable to a wide range of soils and climate; is declining in popularity.

Agen. (D.) (French Prune, Petite Prune.) The ideal plum for prune making in France and America. Rich in sugar and solids. Tree medium size, upright-spreading, dense-topped, hardy, very productive; fruit 1½x1⅛ inches, obovate; skin thin, tough; flesh greenish-yellow, tender, sweet, aromatic, very good to best; pit semi-free to free; cures into a firm, sweet, long-keeping prune, which in cooking needs relatively little sugar. Eaten fresh, it is an excellent dessert plum. It hangs well on the tree. Season late. Tree is a regular bearer and bears abundant crops of fruit uniform in size. More than one type in cultivation.

America. (N.) Golden-yellow, turning red when ripe. Good shipper and for cooking. Productive; hardy.

Archduke. (D.) Tree medium size, upright-spreading; fruit, 1¾ x 1⅜ inches long oval, color reddish-purple to dark-blue; flesh golden-yellow, often a little reddish, juicy, coarse, firm, sweet, pleasant, good, stone free; its large size, handsome color, firm flesh and skin, good shipping and keeping qualities should fit it for a leading place as a commercial plum. Season late.

Arctic. (D.) Tree small, medium in vigor, upright-spreading, hardy, productive, early bearer, subject to fungus troubles; fruit, 1⅜x1¼ inches, oval, color dark-purple to purplish-black; flesh light-yellow, juicy, coarse, fibrous, somewhat firm, tender, sweetish, mild, of fair quality. Its small size, poor quality and the dwarf tree prevent its being grown where less hardy varieties can be grown. Midseason.

Bavay. (D.) One of the best of the green plums, unexcelled for dessert and culinary purposes, also an excellent market plum, keeping and shipping well, flavor not quite equal to Reine Claude. Tree medium size and vigor, upright-spreading, open-topped, hardy, very productive, apt to over-bear, early bearer, susceptible to sunscald; fruit of medium size, roundish, oval; flesh rich golden-yellow, juicy, tender, sweet, good flavor; very good, excellent for home orchard and for commercial use. Season late.

Bradshaw. (D.) (Niagara, Large Black Imperial.) Tree large, vigorous, broad-vasiform, dense-topped, hardy, very productive, grows well in the nursery, rather slow grower when planted, slow in coming into bearing, regular bearer; fruit large, 2½x1¾ inches, oval, attractive appearance, good shipper, light purplish-red to dark reddish-purple; flesh dull-yellow, often with a trace of red, juicy, somewhat tender, sweet, pleasant, good. It ripens in the midst of the peach season, which is against it.

Burbank. (J.) Tree large, vigorous, easily recognized by its low sprawling habit and flat open top, hardy for a Japanese variety, very productive, healthy; the wood is quite brittle; fruit, variable in size, large if thinned, roundish-conic, dark-red over yellow; skin thin, tough, sour; flesh deep-yellow, juicy, tender, firm, sweet, aromatic, good, of better quality than Abundance, keeps and ships better, is less susceptible to brown-rot, ripens a week later than Abundance; fruit needs thinning to get good size usually, is of poor quality and rots badly when grown in the South. Season early.

Clyman. (D.) Tree rather large, vigorous, round, dense-topped, semi-hardy, grown in California for shipping eastward; fruit 1½x1⅜ inches, oval, purplish-red; skin tender, sour; flesh pale-yellow, dry, firm, sweet, mild, of good quality. In New York, its faults are,—the plums are susceptible to rot,—they drop as soon as ripe,—trees are not quite hardy. One of the earliest good Domesticas.

Compass. (N.) Tree small in size, spreading, open-topped, productive; fruit, small ⅞x¾ inch, ovate, light-red to dark-red; flesh light, greenish-yellow, very juicy, melting, sub-acid, poor quality, has some commercial value in the Northwest. It is a cross between the Sand Cherry and the Miner plum. Season early.

Desoto. (N.) This is a native Americana, found in Wisconsin. Tree small, spreading, open-topped, hardy, bears young, with annual heavy crops; fruit, 1½ inch diameter, roundish to oval, yellowish-red to dark-crimson; flesh golden-yellow, very juicy, tender, melting, medium sweetness, fair to good. Owing to its tendency to overbear, it must be thinned. One of the best native varieties, somewhat subject to curculio and to blight in the South, easily injured by drought. Midseason.

Diamond. (D.) Tree above average size and vigor, upright-spreading, hardy, very productive; fruit, 1⅞ x 1¾ inches, oval, deep reddish-purple to dark purplish-black; skin thin, rather sour; flesh pale or golden-yellow with faint-red tinge near the skin, not juicy, coarse firm, rather tender, mild sub-acid, not high in flavor, fair quality. Owing to its firm flesh and tough skin, it is planted as a market plum. Owing to its size, vigor of the tree and its hardiness and productiveness, it meets commercial requirements but its quality is poor. Midseason.

Duane. (D.) Tree large, vigorous, hardy, productive; fruit large size, oblong oval, dark reddish-purple to purplish-black; flesh pale-yellow, firm, sour unless fully ripe, and of fair quality, unfit for dessert, good for culinary purposes, looks well on the stand but is not so good to eat.

French Damson. (D.) The largest of the Damsons; trees large, vigorous, spreading, hardy, productive; fruit, 1½x1⅛ inches, dull-black color; skin thin, tough; flesh greenish, juicy, tender, sweet, pleasant, good. This is an excellent variety, ripens about a week after Shropshire and is worthy of further planting. Season late.

German Prune. (D.) (Various Syn.) Several types are on the market. Tree medium to large, vigorous, round, dense-topped, hardy, usually very productive; fruit, 1⅝x1 inch in size, oval, purplish-black; flesh yellowish-green, medium juicy, firm, sweetish, mild, pleasant flavor, good to very good. The fruit is not as large as the Italian prune. The trees can be grown from seed. The healthy, hardy, vigorous, productive trees tend to make it a favorite, in spite of the small size of the fruit. Season late.

Giant. (D.) Tree medium in size and vigor, round, dense-topped, hardy, usually productive; fruit, large, 2x1½ inches, obovate, light to dark purplish-red; flesh light golden-yellow, coarse, firm, rather sweet, mild, fair in quality.

Its quality is a disappointment. The tree also lacks vigor and productiveness. It does not cure well as a prune although it is a very good shipping plum. It is of doubtful commercial value. Midseason.

Golden Drop. (D.) (Golden Gage, Silver Prune.) The largest, handsomest and best of the yellow plums which is at home in the South and on the Pacific coast. It is excellent for dessert, cooking, canning, preserving or prune making. Tree medium to large, vigorous, spreading, or roundish, open-topped, fairly hardy, productive; fruit, 2x1½ inches, oval, golden-yellow; flesh light, golden-yellow, juicy, moderately firm, tender, sweet, mild, pleasant flavor, good to very good. It lacks vigor and hardiness in New York where the fruit buds are often caught by the cold, rendering the tree a poor producer. It requires a longer season than New York can give it and is subject to many ills in such a location. Season very late.

Gonzales. (N.) A promising plum for the South, color bright-red.

Grand Duke. (D.) One of the favorite late-shipping plums of New York, on account of its large size, its handsome plum-purple color, firm meaty flesh; although it is but second rate in quality in New York, as a dessert fruit, it is good when cooked. Tree above medium size, moderately vigorous, upright to slightly spreading, usually hardy, productive, grows poorly in the nursery and slowly in the orchard, comes into bearing slowly but bears regularly and abundantly; fruit usually large, oval, reddish-purple to purplish-black; flesh golden-yellow, juicy, firm, sweet, and not high in flavor; a good late market plum. Season late.

Gueii. (D.) A money-maker in New York, of little use for home consumption, quality poor. Tree large, vigorous, spreading, open topped, hardy and very productive; fruit medium to above in size, dark-purplish-black; flesh greenish-yellow, firm, tender, mild, fair quality, quite subject to brown-rot, the early bearing habit of the tree and the abundant crops make it of commercial importance. Midseason.

Hammer. (N.) A late plum grown where hardiness is essential.

Hand. (D.) One of the largest of the Reine Claude plums, excellent in flavor when fully ripe and a good dessert plum. Tree large, vigorous, spreading, hardy, but is usually not productive; fruit medium size, yellow color; flesh golden-yellow, very good flavor, and of value for the amateur only. Not commercial. Midseason.

Hanska. (NX.) Originated by Professor Hansen and adapted to the northern states of the Great Plains.

Hawk Eye. (N.) One of the widely planted American plums. May be planted where it is too cold for European plums. Tree large, vigorous, rather upright at first, becoming spreading and low-headed, difficult to train, hardy, usually productive, quite subject to shot-hole fungus; fruit 1⅛ inches diameter, oval, dull-carmine color; flesh pale, dull-yellow, very juicy, watery, sweet at first with tart astringent after taste, subject to brown-rot. Midseason.

Ickworth. (D.) Tree large, rather vigorous, upright-spreading, hardy, productive; fruit 1⅜x1¼ inches, oval, purplish-red to purplish-black, skin thick, tender; flesh dull-yellow, juicy, sweet, mild, pleasant, good. It does not always mature in New York. It is one of the best of the late plums in England, grows well in California where it makes a very good prune or can be shipped green. It is deficient in size. Season very late.

Imperial Epineuse. (D.) Tree large, vigorous, spreading, fairly productive, fruit, large, slightly obovate, purplish-red; flesh greenish-yellow, sweet, good to very good, is unsurpassed in quality by any other plum of its color. It is one of the largest plums in the prune group. Season late.

Imperial Gage. (D.) Tree large, vigorous, upright-spreading, open-topped, hardy, very productive; fruit oval, medium size, color dull, greenish-yellow; flesh golden-yellow, juicy, firm, tender, sweet, good to very good. One of the most capricious of all plums. Is best adapted to light sandy soils on which the fruit is the largest of all the Reine-Claude plums. On heavy clay soil the fruit is small, poorly colored and worthless. Midseason.

Italian Prune. (D.) One of the most widely grown of all plums. The leading plum in the Western states where it is used for prune making and for shipping fresh, one of the best of the prunes for dessert purposes and excellent when cooked, makes an excellent cured prune and is an excellent shipper when fresh. Tree usually large, hardy, productive, well-formed, spreading or upright, low-topped, and regular bearer, often capricious as to soil and climate and in poor locations does not bear well, failing in dry or hot weather; fruit good size, 1⅞x1½ inches, long oval, color purplish-black; flesh greenish-yellow to yellow, juicy, firm, sub-acid, very good to best. Season late. Type variable, probably due to importation of plants showing variation.

Jefferson. (D.) One of the best of all dessert prunes, golden-yellow, large for a Reine Claude. Tree medium to large, vigorous, spreading, open-topped, hardy, productive, but late in coming into bearing and particular as to soil. If not planted under right conditions, is not productive, is too delicate for commercial work, excellent for home use; fruit 1⅝x1½ inches, brownish-yellow when ripe; deep-yellow flesh, firm, tender, sweet, very good quality. Midseason.

Kelsey. (J.) A Japanese plum not much more hardy than the fig. Fruit large, good quality. Grown in the South.

Lombard. (D.) One of the widely grown plums of the United States. Its tree characters are all good, it is frequently recommended as a stock upon which to graft weaker growing plums. It does very well when canned, cooked, preserved or spiced, but as a dessert plum it is poor in quality. It is much used in the canneries and is planted in sections where none but hardy plums can stand the climate. Tree medium size, round-topped, very hardy, productive; fruit mid-season which brings it in competition with the peach, 1¾x1⅝ inches in size, oval, light to dark, purplish-red; flesh yellowish, juicy, firm, sweet, mild, inferior in quality. The crop needs thinning. The tree is apt to over-bear. Midseason.

McRae. (J.) A promising variety for the Gulf Coast states and Florida.

Middleburg. (D.) Tree above medium size, vigorous, round and open-topped, hardy, productive; fruit 1⅝x1½ inches, oval, color light to deep, purplish-red; flesh light-yellow, rather juicy, somewhat coarse, firm, sprightly, strongly aromatic, pleasant flavor, very good; one of the best of all purple plums, either for dessert or cooking; ripens late, hangs well, ships well and is worthy of further trial. Season very late.

Miner. (N.) Tree large, vigorous, spreading, hardy, unproductive unless cross-pollenized; fruit medium size, dark-red; flesh pale, amber-yellow.

juicy, mild, aromatic, of good quality; one of our standard native plums and of value for the Central states where its attractive appearance and the good quality of its fruit renders it especially valuable for culinary purposes. Season late.

Monarch. (D.) Tree medium size and vigor, upright-spreading, open-topped, usually productive; fruit 2x1¾ inches size, roundish-oval, dark-purplish-red; skin thin, tender; flesh golden-yellow, juicy, tender, sweet next to the skin, pleasantly tart towards center, aromatic, good. Season late.

October. (J.) Tree variable in size and figure, upright-spreading, open-topped, hardy for a Triflora, not uniform in productiveness, healthy, fruit ripening period long; 1⅞ inches diameter, roundish-cordate or slight oblate; skin thin, tough, sour; flesh light-yellow frequently touched with red, very juicy, slightly fibrous, variable in firmness, sweet, mild, lacking the strong characteristic Triflora flavor, good. Midseason.

Pacific. Tree medium size, upright-spreading, open-topped, hardy, productive; fruit 2x1⅝ inches, ovate; skin thin, tough; flesh pale, golden-yellow, juicy, firm, sweet, spicy, good, stone free. Midseason.

Peters. (D.) Tree very large, vigorous, round and dense-topped, hardy, productive; season rather short, 1½ inches diameter, roundish; skin thin, tough; flesh golden-yellow, juicy, somewhat fibrous, firm but tender, sweet next skin but sour near center, pleasant flavor, very good. Season late.

Pond. (D.) Tree medium size, vigorous, upright, hardy, variable in productiveness; fruit season short, 2x1¾ inches size, obovate or oval, reddish-purple to purplish-red; skin tough; flesh golden-yellow, very juicy, fibrous, firm, of average sweetness, mild, not highly flavored, fair quality. Season late.

Pottawattamie. (N.) Tree medium size, strong and vigorous when young becoming spreading and somewhat dwarfish when older, round-topped, hardy in Geneva, N. Y., usually productive; fruit early, season medium length; variable size from ⅞ to 1⅛ inches diameter, roundish-oval, clear currant-red, with thin bloom; skin tough; flesh deep-yellow, juicy, fibrous, tender and melting, sweet next skin, sour at center, pleasant flavor, fair to good quality. Midseason.

Quackenboss. (D.) Tree very large and vigorous, round-topped, hardy, productive; fruit season short; 1⅝x1⅜ inches, roundish-oval, bluish-black; skin tender, somewhat astringent; flesh deep-yellow, juicy, tender, sweet, of pleasant, mild flavor, good. Season late.

Red June. (J.) Tree large, vigorous, upright-spreading, hardy, productive, healthy; fruit, 1½x1⅜ inches size; garnet-red, tender; flesh light-yellow, good. Season early.

Reine Claude. (D.) Tree medium size and vigor, round-topped, hardy, productive; fruit, 1¾x1⅝ inches size, roundish-oval, yellowish-green, becoming golden-yellow at maturity; skin tough; flesh greenish-yellow or golden-yellow, juicy, firm, sweet, mild, very good. Midseason.

Sapa. A hardy plum originated by Professor Hansen and adapted to the Northern plains.

Sergeant. (D.) Tree upright, fruit midseason, medium size, roundish-oval; skin deep-purple to black; flesh greenish-yellow, sweet, highly flavored, quality good. Some regard it as synonymous with Agen.

Shipper. (D.) Tree large, vigorous, round-topped, hardy, productive;

fruit, 1½x1⅜ inches, ovate, purplish-black; skin thin, tender; flesh greenish-yellow rather tart, firm, sweet, mild in flavor, inferior in quality. Season late.

Shropshire. (D.) Tree large, vigorous, vasiform, hardy, productive; fruit, purplish-black, season long, 1½x1 inch, oval; skin thin, tender; flesh golden-yellow, juicy, firm but tender, agreeably tart at full maturity, sprightly, pleasant. Season late.

Smith Orleans. (D.) Tree large, vigorous, spreading, open-topped, very productive; fruit, 1⅝x1½ inches, oval, dark, purplish-black; skin below medium in thickness, tender, sour; flesh pale yellow, juicy, tender, sweet, pleasant flavor, good. Midseason.

Sugar. (D.) Tree medium size, very vigorous, spreading, dense-topped, hardy, productive; fruit, ovate or oval, color dark, reddish-purple, changing to purplish-black; skin thin, tender; flesh golden-yellow, juicy, coarse, fibrous, tender, sweet, mild, good to very good. Midseason.

Surprise. (N.) One of the best of the natives. Tree large, vigorous, upright, dense-topped, hardy, productive; fruit, ripening season short, 1⅜x1⅛ inches; dark-red; skin thick, tough, clinging; flesh golden-yellow, juicy, fibrous, somewhat tender, sweet, insipid, quality fair. Midseason.

Tennant. (D.) Tree large, vigorous, round-topped, open, hardy, productive; fruit, 1¾x1⅝ inches, roundish-truncate or roundish-oblong, dark reddish-purple; skin tough, adhering slightly to the pulp; flesh dark-golden-yellow, somewhat dry, coarse, tough, firm, sweet, mild but pleasant, good quality. Midseason.

Tragedy. (D.) Tree large, vigorous, round-topped, hardy, variable in productiveness; fruit, season short, 1⅝x1⅜ inches, oval, dark-purplish-black; skin medium thickness and toughness, somewhat sour; flesh greenish-yellow, juicy, tender, sweet, mild, good. Season early.

Washington. (D.) Tree large, vigorous, round and open-topped, hardy, very productive; fruit, 1¾x1⅝ inches, roundish-oval, greenish-yellow or light-yellow; skin thin, slightly sour; flesh greenish-yellow, juicy, firm but tender, sweet, mild, pleasant flavor, good to very good. Midseason.

Wayland. (N.) Tree large and vigorous, spreading, somewhat drooping, flat-topped, open, hardy in Geneva, N. Y., productive; fruit season long, 1⅛x1 inch, roundish-ovate, narrowing somewhat toward the stem, conical, dark, currant-red; skin thick, tough, clinging but slightly; flesh attractive light-yellow, moderately juicy, coarse, fibrous, rather tender, mildly sweet next skin, astringent towards the pit, fair to good. Season very late.

Wickson. (J.) Tree medium to large, vigorous, with narrow, upright head, dense-topped, tender to cold, an uncertain bearer; fruit ripening period long, variable in size, larger fruits about 2⅛ inches diameter, obliquely cordate, dark-red over a yellow ground; skin thin, tender; flesh amber-yellow, juicy, coarse, somewhat fibrous, firm, sweet, pleasant but not high in flavor, good. Early midseason.

Wild Goose. (N.) Tree very large and vigorous, wide-spreading, flat-topped, hardy in New York, productive; fruit, season medium length, 1⅜x1$\frac{3}{16}$ inches, oval, bright-red; skin tough, slightly astringent; flesh yellowish, very juicy and fibrous, tender and melting, sweet next skin, sour at center, sprightly, fair to good. Season very early.

Wolf. (N.) Tree large, vigorous, spreading, low, and open-topped, hardy, productive, healthy; fruit ripening period short, less than 1 inch diameter, roundish-oval or somewhat obovate, dull-crimson; skin thick, tough, slightly roughened, astringent, adhering; flesh golden-yellow, very juicy, fibrous, tender and melting, sweet next skin, astringent toward center, fair to good. Midseason.

Wood. (N.) Tree medium size, spreading, hardy, dense-topped, annual and abundant bearer; fruit, ripening period short, 1¼ inches diameter, oblate, dark-red over yellow ground; skin thick, tough, sour, adhering; flesh orange-yellow, juicy, coarse, fibrous, tender and melting, sweet, lacking in flavor, fair quality. Midseason.

Wyant. (N.) Tree small, spreading and straggling, flat-topped, very hardy, productive, healthy; fruit, ripening period short, 1¼ inches diameter, not symmetrical in shape, oblong-obovate to nearly ovate, somewhat truncate, dark-carmine over yellow ground; skin thin, tender; flesh dark, golden-yellow, juicy, tender and melting, sweet, with Americana flavor less marked than in other varieties, fair quality. Midseason.

Yellow Egg. (D.) Tree large, vigorous, round-topped, open, hardy, very productive; fruit, season short, 2x1⅝ inches, long-oval, golden-yellow; skin thin, slightly astringent; flesh golden-yellow, rather juicy, moderately coarse, firm, average sweetness, mild, good. Season late.

POMEGRANATES

Wonderful. The leading variety, 75 per cent of the commercial fruits in California are of this variety. Fruit is large, attractive, deep, purple-red, glossy, flesh deep crimson, flavor excellent, vinous, rich and sprightly, seeds fairly tender, rind medium in thickness.

Paper Shell. Large, attractive, pale-yellow, with pink gloss, flesh bright-red, juice abundant, bright-red, flavor good, seeds tender, rind very thin, excellent for home use, tree not so vigorous as Wonderful, second in importance in California.

Spanish Ruby. Large, attractive, bright-red, glossy, flesh crimson, juice abundant, bright-red, flavor sweet, aromatic, seeds fairly tender, rind medium in thickness. Sometimes called ''purple seeded'' or ''purple variety.'' Found distributed through the Southern states. The third in importance in California.

Sweet. Medium size, pale-yellow, lightly-striped with pink, flesh pale-pink, juice moderate in amount, flavor pleasant, aromatic, seeds fairly tender, rind medium.

Sub-acid. Medium size, pale-yellow with pink cast, flesh red, juice moderate in amount, flavor tart, sour, seeds not edible but easily chewed, rind thin, very much like the Sweet but more acid.

POMELOS, GRAPEFRUIT

(Dates for Florida unless otherwise stated)

Aurantium. (Orange.) Oblate, small to medium, color light-yellow; rind smooth, flavor good; juice moderately acid; seeds thirty-five; medium early; a sweet orange and pomelo hybrid.

Desoto. Oblate; size medium; color light-yellow; rind medium thick; flavor good; seeds forty-three; late.

*__DUNCAN.__ Oblate; size medium-large; color yellow; rind medium thickness; flavor good; seeds five or more; late; hangs well. One of the hardiest and one of the most extensively grown in Florida.

Excelsior. Oblate; size medium; color lemon-yellow; rind slightly pitted; flavor good; seeds thirty-one; late. Tree desirable, productive in Florida.

Foster. Fruit large, flesh purplish-pink next to the skin. Ripens early.

Hall. Oblate; size medium to large; borne in large clusters, color light-yellow; rind medium thickness; flavor good; seeds thirty-two; late February to March. A favorite in Florida.

Josselyn. Roundish; size small; color yellow; rind smooth; flavor good; seeds forty-eight; December to January.

Leonardy. Rounded; size medium large; color lemon-yellow; rind smooth; flavor very good; seeds twenty-eight; January.

Manville. Oblate; size medium to large; color lemon-yellow; rind smooth; flavor very good; seeds numerous—sixty to seventy. Late.

McCarty. Fruits large, borne singly, seeds numerous.

McKinley. Oblate; size medium; color pale-yellow; rind smooth; flavor one of the best; seeds sixty-two. Late.

Marsh. Rounded; size small to medium; color light-yellow; rind smooth; flavor excellent; seeds forty-four. Early to medium, November to February.

*__Marsh Seedless.__ Roundish; size medium; color light-yellow; rind thin, smooth; juice abundant; flavor fair; pith large, open; hangs well; seeds few to none; tree productive; late February to March in Florida; January to July in California. The leading commercial variety in California and Arizona, where it appears to do better than most Florida varieties.

Nocatee. Roundish; size small; color yellow; rind medium thick, easily removed; flavor delicate, rich when mature; seeds few to none; hangs extremely well; December to August, at its best in April.

Pernambuco. Oblate; size medium; color light-yellow; rind medium thickness, smooth; flavor very good; seeds many, sixty to seventy-five. Late.

Royal. Oblate; size medium; color light-yellow; rind thin; flavor sweetish, can be eaten like an orange; seeds forty. Medium to late. Tree a good bearer.

Indian River. Oblate; size large; color very light-yellow; rind thick; flavor excellent; seeds forty-nine to fifty-nine. Medium to late—January to March. One of the best varieties.

Triumph. Oblate; size medium; color light-yellow; rind very smooth, thin; flavor average; seeds thirty-seven; medium early; tree rather tender; does not succeed when budded on sour orange.

Walters. Oblate; size medium to large; color pale-yellow; rind smooth; flavor very good; seeds fifty-eight. Midseason.

SHADDOCKS, PUMMELOS

Mammoth. Oblate; size large; color lemon yellow; flavor sweetish bitter; seeds twelve; flesh white; season winter.

Pink. Oblate and necked; size large; color lemon-yellow; rind thick; flesh pink or red; seeds three to seven; season winter.

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* Leading commercial varieties.

QUINCES

Bourgeat. Tree large, vigorous, productive; fruit medium, round, short neck, greenish-yellow; good.

Champion. Tree upright grower, large, vigorous, bears young; fruit large, pear-shaped; skin greenish-yellow. Late. A very good keeper.

Meech. Ripens two weeks earlier than Champion and is more productive; tree vigorous, hardy, productive, fairly free from blight, bears early; fruit midseason, very large, pear-shaped, bright, golden-yellow; flesh yellowish-white, good.

Missouri. Ripens with Orange or a little earlier, but is not so desirable. Fruit large, bright lemon-yellow, very good.

Orange or **Apple.** (A group name.) The trees are vigorous, hardy and fairly free from blight; fruit early midseason, nearly round, short neck, golden-yellow or greenish-yellow, with pale-yellow flesh, tender, mild, subacid. Very good. Adapted to the North, mature too early for the South.

Rea. A strain of Orange which it resembles but is larger, more globular and lighter in color.

Smyrna. Suits California. Tree rapid, vigorous grower; fruit large, round-oblong, lemon-yellow, matures with Orange, keeps well, very good.

Van Deman. Tree hardy, prolific, productive; fruit ripens ahead of Orange, very large, pear-shaped, short neck, very good.

New Varieties Recently Developed by Luther Burbank Include:

Alpha. Fruit large, handsome; tree hardy, vigorous, productive.

Childs. An early, lemon-yellow, large quince, nearly round; tree strong grower, productive.

Elephant. Orange-colored yellow flesh fruit, very large.

Pineapple. Resembles Orange but the flavor suggests the pineapple.

Santa Rosa. Very large, light, lemon-yellow, very good flavor; tree vigorous, productive.

RASPBERRIES

Red Raspberries

Brilliant. Early midseason, ahead of Cuthbert; fruit medium to small, not high in flavor. Grown in New Jersey and Delaware. Not hardy north of this.

Cayuga. (New.) Seedling June X Cuthbert. Fruit large, firm, juicy, very good. Canes vigorous, very productive. Agr. Exp. Sta. New York.

Cuthbert. Midseason to late. Fruit large, firm, juicy, very good. Canes vigorous, productive; one of the most popular. Origin, New York.

Empire. (New.) Vigorous, productive, hardy, esteemed in Hudson River Valley, New York. Fruits larger than Cuthbert, a little earlier, best in quality.

Herbert. Midseason to late. Fruit larger, softer and more productive than Cuthbert. Hardy in Canada. Origin, Canada.

June. Very early, productive, long season, fruit large, ships well. Plants hardy, vigorous, few suckers. Agr. Exp. Sta., New York.

King. The best early in West Virginia southward. Hardy in Minnesota.

Latham. (Minn. No. 4.) Vigorous, productive, midseason, hardy in Minnesota.

Loudon. Large, juicy, firm, good. Productive, hardy, good shipper. Wisconsin.

Marlboro. Early; plants dwarfish, hardy, productive. Fruits large, firm, moderate quality. New York.

Marldon. Season short, just ahead of Cuthbert; bushes vigorous, productive; berries large. New York.

Ontario. Vigorous, productive, early midseason. Fruits very large.

Owasco. (New.) Fruit very large; plants moderately vigorous. Seedling June X Cuthbert. Agr. Exp. Sta., New York

Perfection. Early. Berries large; bushes stocky, productive. Practically ruined by mosaic.

Ranere, St. Regis. Everbearing. One of the best of the fall-bearing varieties. Ripens a crop in September on canes grown the same year. Not commercial.

Redpath. (New.) Vigorous, hardy, productive, large berries. Minnesota.

Ruby. Resembles its parent, Marlboro.

Seneca. (New.) Resembles Cayuga, same breeding, but is later. Agr. Exp. Sta., New York.

Sunbeam. Very hardy, suitable for the northern Great Plains.

Superlative. European, excellent for home use. Not hardy in the Northeastern states. Standard on the Pacific Coast.

Syracuse. Resembles Superlative.

PURPLE RASPBERRIES

Cardinal. Suitable for the Central West, and north and south of where Columbian will thrive.

Columbian. Midseason; fruit large, firm, nearly sweet. Canes tall, vigorous, productive, firmer than Shaffer. New York.

Royal Purple. Very hardy, two weeks later than Columbian.

YELLOW RASPBERRIES

Golden Queen. A yellow Cuthbert, midseason; fruit pale-yellow, very good quality, soft, of value for home use.

Japanese Golden Mayberry. The earliest raspberry known, golden-straw color, as large as Cuthbert, ripens ahead of strawberries. Sent out by Luther Burbank.

BLACK RASPBERRIES

Black Pearl. New, early. Fruit large, attractive, black. Plants vigorous, productive, hardy, healthy. Rising in importance.

Cumberland. Early to midseason. Large glossy black, firm, berries of excellent quality. Strong, hardy, vigorous bush but subject to anthracnose.

Diamond. Midseason, fruit too small, good shipper. Bush vigorous, less subject to anthracnose than some others. Partial to localities. Follows Kansas four or five days.

Eureka. Early. Medium to large, firm, of fair quality, good size and color. Declining as a market variety.

Gregg. Late, large, good quality. Variable in productivity. Strong grower, lacking in hardiness and is declining.

Kansas. Winter kills badly, berries often imperfect. Is losing its position as a commercial variety.

Ohio. Early. Medium size, of fair quality, very productive, ships well. Has large seeds and consequently shrinks little on drying, hence is used for that purpose but the call for dried raspberries is passing.

Palmer. Declining in favor, lacked productiveness.

Plum Farmer. Early midseason. Very productive, highly regarded commercially.

Scarff. The largest berry of all blacks, and of high quality. Plants vigorous, productive.

STRAWBERRIES

Abington. (Perfect.) Early, midseason, very productive, bright-red, long, conic to wedge-shaped; foliage susceptible to leaf spot. Plant makes runners freely. Is grown in New England. Berry very soft; for home use only.

Americus. Everbearing (Perfect.) Berries medium, light-red, good flavor. Does best on rich soils with some clay in them. Fruit is said to be larger the second year than the first.

Arizona. Midseason, light-red, soft, good quality; plant makes few runners. Has been a leading variety in Arizona and the Pacific southwest where drought resistance is important.

Aroma. (Perfect.) Late; the leading commercial variety in Kentucky, northern Arkansas and southern Missouri; grown extensively in the north Central states, West Virginia and Delaware. Berry is large, wedge-shaped, firm, crimson, excellent shipper, high quality and attractive. Foliage healthy; plants make many runners.

Brandywine. (Perfect.) A standard variety in Southern California where it is free from leaf spot. Grown to a small extent in New England, Michigan, where it is somewhat subject to leaf spot. Berries large, dark-red, very good quality, late.

Bubach. (Imperfect.) Midseason. Berry large, rather soft, good quality. Plants make few runners. Adapted to heavy soils, grown in the Middle West.

Campbell. (Perfect.) Early, medium to large, very good quality, uniform, ships well, productive. Grown in New Jersey.

Chesapeake. (Perfect.) Midseason; berry large, firm, bright-crimson, quality very good. Foliage remarkably healthy. Plants make few runners except in rich soil. Grown in New Jersey to Maryland. Does well under irrigation. Good for home use in northern United States east of the Mississippi.

Chipman. (Perfect.) Early. Fruit medium size, good quality. Foliage subject to leaf spot. A favorite in the Chesapeake Peninsula.

Clark. (Perfect.) Midseason. Grown for canning in the Pacific northwest. The chief variety grown in the Hood River and White Salmon regions. Berries medium size, very firm, dark crimson, good quality. Foliage healthy, makes runners freely. Not a heavy producer.

Columbia. Late. A good home use berry for the same region as Chesapeake. Fruit large.

Dr. Burrill. (Perfect.) Late midseason; doing well in south Illinois. Large, medium to dark-red, fair to good.

Dollar. (Perfect.) Midseason to late. Grown in the Sacramento Valley, California. Berries large, firm, good quality. Ripens over a long season.

Dunlap. (Perfect.) Midseason. This variety is grown almost exclusively in the northern Mississippi Valley and over a greater portion of the Northern states east of the Rockies. Fruits large, moderately firm, dark-colored, good quality. Foliage healthy, but subject to leaf spot in the Southern states. Plants make runners freely, hardy. Home use and local markets.

Early Hathaway. (Perfect.) Early. Berry medium size, scarlet, fair quality, foliage healthy, plants make runners freely. Grown in northern Alabama, Kentucky, Maryland, where it is productive, but is losing ground.

Echo. (Perfect.) Midseason, large, good to very good quality, excellent shipper in the Falmouth berry region, Massachusetts.

Ford. (Perfect or semi-perfect.) Very late, very large, dark-red, excellent quality; blooms late.

Francis. (Everbearing, Perfect.) Needs abundant water supply. Roots very short. Will not withstand drought. Does not make runners freely. Fruit large, irregular in shape.

Gandy. (Perfect.) Late. Fruits large, firm, deep-crimson, good quality; foliage healthy; plants make runners freely. Is liked for canning; does best on moist heavy clay soils. Fruits apt to decrease in size if plants are carried more than one year. Grown extensively in Maryland, Delaware, New Jersey, and throughout the northern United States except in the colder parts of the Central states.

Glen Mary. (Imperfect.) Midseason. Berries large, somewhat soft, deep-crimson, good quality. Fruit stems too slender to hold the fruit off the ground. Foliage subject to leaf spot; plants make runners freely; best adapted to heavy soils; grown in New York and New England. Needs heavy feeding with manure and nitrate of soda.

Gold Dollar. (Perfect.) Early. Berry medium to large; grown in Oregon, where it is considered one of the best early varieties.

Good Luck. (Perfect.) Late, large, handsome, sprightly, somewhat acid for dessert, excellent canned or cooked. Very firm, excellent shipper. Tips ripen slowly, develops many runners.

Jessie. (Perfect.) Late. Berry medium to large; moderately firm. Is grown commercially near Sacramento, California. Needs rich soil and high cultivation.

Joe (Big Joe). (Perfect.) Midseason to late. Very large, dark-crimson; quality good. Foliage healthy; makes runners freely on good soil. A good shipper; grown extensively in Maryland, New Jersey and Delaware.

Jucunda. (Perfect.) Late; grown commercially in parts of Colorado.

Kellogg Prize. (Imperfect.) Late, medium to large, fair to good quality. Ships well.

Klondike. (Perfect.) Midseason. Berry medium to large, very firm, good quality. Foliage healthy; plants make runners freely. Grown almost exclusively in the South Atlantic and Gulf Coast states and extensively in

Southern California and parts of Missouri, Illinois, Maryland, Delaware. One of the best shipping varieties and especially adapted to market purposes. Good canner, loses size as the season advances.

Late Stevens. (Perfect.) Late. Fruit large, firm, fair quality; grown considerably in New Jersey, Delaware and parts of New York for market.

Magoon. (Perfect.) Midseason. Berries medium to large; dark-crimson; good quality; grown in the Willamette Valley in Oregon and in Washington. Too soft for shipping.

Marshall. (Perfect.) Midseason. Berries large, very deep-crimson. Foliage fairly healthy in New England and New York; subject to leaf-spot further South. Plants make runners freely, especially adapted to heavy soils. Excellent for home use where good cultivation can be given. Needs rich soils.

Mascot. (Perfect.) Late. Grown in New Jersey, Delaware, Maryland, because it is later than Gandy. Is very productive; has very large berries of excellent quality. Is recommended for trial where Gandy succeeds.

Missionary. (Perfect.) Early to midseason. Berry medium to large; soft to very firm according to the section where grown. Dark crimson, fair to good quality. Foliage very resistant to leaf-spot. Plant makes runners freely. The standard variety for Central Florida. Grown also in the eastern part of North Carolina, the Norfolk region of Virginia, parts of eastern Maryland. Is a firm, excellent shipping berry when grown in Florida.

New York. (Perfect.) Midseason. This variety has many synonyms as Otto, Oswego, Pocahontas, Roosevelt, etc. Berries large to very large, soft to firm, crimson, quality very good. Because of its sweet flavor, it can be eaten by many who cannot eat a more acid berry. Foliage healthy in the Northeastern states. Plants make runners freely.

Nich Ohmer. (Perfect.) Midseason to late. Is grown in the Watsonville region, California; firm, attractive, of good dessert quality. In the east, the fruit is often of poor quality, foliage subject to leaf-spot.

Oregon. (Perfect.) Early to midseason. Berry medium to large, fairly firm, dark-crimson. Grown chiefly in the Pacific Northwest and in the vicinity of San Francisco, California. Desirable for home use and for market.

Parsons. (Perfect.) Midseason. Berry medium to large, bright-crimson, good quality; foliage subject to leaf-spot. Plants make runners freely. Grown chiefly for canning, the fruit retains its shape fairly well after cooking. The hull is easily removed. Flesh red, brisk sub-acid, grown chiefly in Delaware and Maryland and Western New York; needs good cultivation and manure.

Pocomoke (Gibson). (Perfect.) Midseason. Grown in Western New York, Michigan, and parts of the Middle West. Hardy, productive, large, attractive fruits which are bright-crimson, good quality and ship well. Foliage fairly healthy; plants make runners freely.

Premier. (Perfect.) Medium early, medium size, good quality.

Progressive. (Everbearing.) (Perfect.) One of the most widely grown of the everbearing varieties, hardy, resistant to leaf spot; has excellent dark-red fruit; is not adapted to the South, will grow North of where the Klondike succeeds. Very small to medium size, good quality.

Sample. (Imperfect.) Midseason to late. Has long season. Berries large; medium firm, dark-crimson, good quality; foliage usually healthy in the North, affected by leaf-spot in southern New Jersey and further south. Plants make runners freely. Is grown in the Northeast and Western states. Commonly pollinated by Dunlap. Berries somewhat soft for shipping.

Sharpless. (Perfect.) Midseason to late, very large, irregular berries, firm, mild sub-acid. Grown on the Pacific Coast. Capricious in bearing, has green tips.

Superb. (Everbearing.) (Perfect.) Berry medium to large. Dark-crimson; quality variable. Foliage healthy; plants generally make runners freely. Will grow on soils which are not rich in nitrogen but which have an adequate water supply. Does well under irrigation in the Northwest.

Superior. ((Perfect.) Early to midseason. Berry medium size, good shipper, used for canning; apt to be small after first picking. Grown to some extent in Delaware and New Jersey.

Trebla. A canning variety originated by Ettersburg and grown in California, where it has produced very high yields. The fruit separates from the calyx when gathered, like a blackberry, saving the canner the expense of ''hulling.''

Warfield. (Imperfect.) Midseason. Berries small to medium. Soft to fairly firm; good quality. Foliage healthy; plants make runners freely. Has been discarded except in the Northern belt where a hardy variety is necessary, as parts of Wisconsin, Minnesota, etc. Fruit is one of the best for canning, but is rather small. Dunlap is commonly used to pollinate.

William Belt. (Perfect.) Late; fruit large, soft, dark-crimson; very good; plants make runners freely, are fairly healthy in New England and New York; further south are subject to leaf-spot. Needs a large supply of nitrogenous fertilizer.

Wilson. (Perfect.) Midseason. Berries usually of medium size, soft to firm; dark-red, good quality. Foliage fairly healthy in New York. Plants make runners freely. Was formerly grown over much of the United States; is now planted little except in parts of Western New York, Oregon, Washington, where it is grown almost entirely for canning. Needs fertile soil, rich in nitrogen.

STRAWBERRY SUGGESTIONS

Varieties for Canning and Juice. For this trade, a berry is required which has good color, which does not fade; the flesh must be firm, deep-red to the center, of sub-acid to acid flavor and it must be easily hulled. Among such are Wilson, grown near Rochester, New York, and in Western Oregon and Washington; Money-maker grown in Monroe and Wayne Counties, New York; Clark in Hood River and White Salmon regions, Oregon and Washington; Melinda, near San Francisco, California; Klondike in Southern California and southern United States, and sometimes as far north as Delaware; Parsons in Maryland, Delaware and the northeastern United States; Warfield in Central Western states. Other varieties sometimes used are Marshall in California, Gandy, Superior, Dunlap, Joe, Missionary. A hull-less variety is now grown in California.

Varieties for Shipping. A variety may be an excellent berry for shipping to distant markets when grown under one set of conditions and be worthless when grown under others. It is therefore difficult to do other than mention the names of the varieties which are regarded most favorably on the market and if one is so situated that this variety is adapted to their conditions it may be the berry to grow for this purpose. Klondike, Aroma, Clark, Missionary, Gandy, Chesapeake, Joe, Campbell, Excelsior, Nich Ohmer.

Fairly Good Shippers. Late Stevens, Echo, Dollar, Sample, Pocomoke, Dunlap, New York, Jucunda. The above are good in some places and too soft to ship in others.

Hardy Varieties. In the upper Mississippi Valley, Progressive is ranked as hardiest, followed by Dunlap and Warfield. Bederwood and Superb would follow.

Varieties having large, showy fruit. Chesapeake, Columbia, Joe, Nich Ohmer, Lupton, Marshall, Oregon, Magoon, Success and William Belt. Others bearing fruit which is almost as large and showy as these are New York, Early Jersey, Glen Mary, Aroma, Gandy, Mascot, Brandywine, Jucunda.

Varieties Having Sweet Fruit. New York is very mild flavored. Marshall, Chesapeake, William Belt, Nich Ohmer, Early Jersey, Superb.

Varieties of High Dessert Quality. This will vary with the taste of the person, also with the place where the variety is grown. Nich Ohmer is insipid when grown in Florida, very good when grown in New Jersey, excellent in California, but generally speaking, Marshall, Americus and Jucunda are in the lead. In the next rank we find William Belt, Chesapeake, Joe, Dunlap, Oregon, Brandywine, Success, New York and Nich Ohmer.

Varieties for Hill Culture. Klondike and Missionary in the South Atlantic and in the Gulf Coast states. In these regions, these varieties, when planted in fall, fail to make runners before fruiting; elsewhere they make a matted row. In humid regions, Chesapeake, Marshall, Joe, Columbia, Superb and Progressive, because these varieties are usually grown to produce fancy fruit. In irrigated regions of the West, most varieties are grown in hills.

Varieties for Canada. (Commercial.) **Maritime Provinces:** Dunlap, Splendid, Glen Mary, Sample, Warfield, William Belt. **Quebec:** Dunlap, Parsons, Splendid, Bederwood, Sample, Pocomoke, Warfield. **Ontario:** Parsons, Glen Mary, Williams, Dunlap, Bederwood, Splendid, Howard 17, Sample, Enhance. **Prairie Provinces:** Dunlap, Dakota, Bederwood, Haverland, Warfield, Tennessee, Prolific. **British Columbia:** Magoon, Dunlap, Marshall, Paxton.

Hardiest Varieties for Canada. Bederwood, Lovett, Dunlap, Pocomoke, Crescent, Dakota (the last being the hardiest on the prairies).

Varieties which make few runners in Canada. Glen Mary, Sample, Parsons, Williams, usually planted 18 inches or so apart to make a matted row.

Varieties which make runners freely in Canada. Warfield, Dunlap, Splendid, usually planted at least 24 inches apart to make a matted row. Rows 3½ to 4 feet apart.

ANNUAL APPLE EXPORTS FROM UNITED STATES AND CANADA

As furnished by International Apple Shippers' Association, for Period 1880-1924

Year	United States Barrels	United States Boxes	Canada Barrels	Canada Boxes	Total Barrels	Total Boxes	Total In barrels
1880-81	1,159,380	......	169,526	......	......	......	1,328,906
81-82	169,014	......	70,238	......	......	......	239,252
82-83	312,662	......	82,732	......	......	......	395,594
83-84	70,329	......	11,203	......	......	......	81,532
84-85	643,516	......	125,694	......	......	......	769,210
85-86	778,575	......	106,698	......	......	......	885,273
86-87	606,608	......	201,319	......	......	......	807,927
87-88	482,711	......	125,710	......	......	......	608,421
88-89	1,021,411	......	385,998	......	......	......	1,407,409
89-90	461,609	......	216,153	......	......	......	677,762
90-91	179,991	......	271,285	......	......	......	451,276
91-92	1,042,530	......	407,836	......	......	......	1,450,366
92-93	657,570	......	545 968	......	......	......	1,203,538
93-94	83,536	......	91,313	......	......	......	174,849
94-95	900,399	......	537,763	......	......	......	1,438,162
95-96	457,431	13,610	293,824	1,861	751,255	15,471	756,412
96-97	1,809,839	......	1,110,007	......	2,919,846	......	2,919,846
97-98	668,475	......	245,521	......	913,996	......	913,996
98-99	539,500	180,636	681,587	1,349	1,221,087	181,985	1,281,749
99-00	646,841	149,515	646,327	......	1,293,168	149,515	1,343,006
1900-01	808,236	203,333	470,020	......	1,346,034	203,333	1,413,812
01-02	398,493	296,427	393,695	......	792,188	296,427	890,997

Annual Apple Exports from United States and Canada—(*Continued*)

As furnished by International Apple Shippers' Association, for Period 1880-1924

Year	United States		Canada		Total		Total
	Barrels	Boxes	Barrels	Boxes	Barrels	Boxes	In barrels
1902-03	1,909,659	212,587	633,100	......	2,542,759	212,587	2,613,621
03-04	2,178,655	388,975	1,326,679	......	3,505,334	388,975	3,635,192
04 05	1,664,169	66,792	747,454	20,529	2,411,623	87,321	2,440,730
05-06	1,297,803	416,266	888,328	......	2,186,131	416,266	2,324,886
06-07	1,565,452	252,011	741,637	......	2,307,089	252,011	2,391,093
07-08	1,340,560	285,206	1,128,968	......	2,469,528	285,206	2,564,597
08-09	658,552	520,792	914,033	......	1,572,585	520,792	1,746,182
09-10	942 652	460,362	1,269,802	......	2,212,454	460,362	2,365,908
10-11	1,249,973	1,106,610	384,004	......	1,634,977	1,106,610	2,002,847
11-12	1,253,524	587,035	1,542,077	......	2,795,601	587,035	2,991,279
12-13	1,814,854	1,453,577	1,146,143	......	2,960,997	1,453,577	3,445,523
13-14	995,694	867,346	780,243	......	1,775,937	867,346	2,065,052
14-15	1,673,842	1,423,132	994,031	......	2,667,873	1,423,132	3,142,250
15-16	902,302	827,708	535,283	......	1,437,585	827,708	1,713,481
16-17—Total only—Details unavailable on account of war conditions							997,256
17-18	None	None	None	None	None	None	None
18-19—Total only—Details unavailable on account of war conditions							1,416,592
19-20	438,923	1,663,754	533,127	176,035	972,050	1,839,780	1,585,323
20-21	1,299,006	2,445,367	1,146,495	276,960	2,145,501	2,722,327	3,352,943
21-22	82,888	2,228,167	1,157,179	382,209	1,240,067	2,610,376	2,110,192
22-23	488,038	2,715,268	1,193,947	530,136	1,681,985	3,245,404	2,763,786
23-24	1,880,894	4,889,200	1,323,245	559,534	3,206,109	5,448,734	5,022,354

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Fertilizers and Crops

OR

The Science and Practice of Crop-Feeding

By DR. LUCIUS L. VAN SLYKE

Chemist of the New York Agricultural Experiment Station

This recent book is a timely presentation of facts not only giving practical methods for using fertilizers in crop growing, but placing special emphasis on the reasons underlying their use and on the conditions of the greatest efficiency. It has been prepared for the use of students in agricultural schools and especially for the larger class of students directly and vitally interested in the growing of crops.

During the past fifteen years, many books have been published relating to soils, crop growing and fertilizers, each treating some special, limited phase; but the publishers have felt for some time that there has been an increasing need of a book different from any of those that have yet appeared. This book is the result of an effort to meet such a demand. At no time in the history of this country has the growing of crops attracted so wide and intense interest as at the present and at no time has there been such eager inquiry for reliable, up-to-date information among progressive farmers. An examination of the book shows that the author has kept in mind the fact that a work treating of the practical use of fertilizers on the farm should be something more than a mere collection of recipes giving the number of pounds of different fertilizing materials to use for this or that crop. The book has been written from the standpoint that, while plant-foods constitute a most important factor in crop growing, there are other vital factors as well which directly affect or control the effectiveness with which a crop utilizes the plant-food furnished it.

The first part of the book covers the factors of soil fertility. This consists of twelve chapters and treats of the relations of plant-food to soil fertility. It discusses, (1) essential plant-food constituents, what they are, where they come from, what particular effects they have in the growth of plants; (2) how plants take and use their food; (3) how plant-foods are lost and gained by soils; (3) the relations of micro-organisms to plant-foods; (4) the relation of water to soils and crops; (5) brief outlines of methods of soil management for the purpose of enabling plants to use their foods most efficiently.

The second part of the book covers the sources and composition of materials used as fertilizers. This consists of eight chapters and gives a full discussion of the various materials used as sources of plant-food. The new fertilizing materials that have only recently come into use are given careful attention. Of special practical value and fullness are the two chapters treating of the composition, changes, care, value and use of farm manure. The subject of green-crop manures is given detailed attention. Of special interest at this time is the very complete discussion of the use of lime on soils.

The third division of the book, factors in the selection of fertilizing materials, contains six chapters and furnishes a large amount of practical information, which will enable farmers to select fertilizing materials for use in crop growing on the basis of greatest suitability, feeding efficiency and economy of cost. Such subjects as the availability of different forms of plant-food materials, when to use commercial fertilizers, what to use, effects of fertilizers upon soils, adaptation to crops, comparative cost in different forms, various phases of commercial fertilizers, with their advantages and disadvantages, home mixing,—are all fully discussed from the standpoint of a farmer seeking helpful information. The principles of crop-rotation are treated in connection with the selection of fertilizers to use.

The fourth part of the book, practical use of fertilizers in the growing of individual crops, is the one to which the practical farmer will probably turn first. The treatment of the methods of using fertilizers is properly conservative but abreast of the most recent developments. The preceding portions of the book form a complete preparation to enable one to make use of this last part in the most intellligent, rational and efficient way. The treatment of the different crops in relation to the use of fertilizers is more complete than in any other book yet published. For example, we have nowhere seen the subjects of orchard crops, greenhouse crops, nursery crops, etc., discussed with such a degree of fulness and appreciation of practical relations, and the same is true of the other chapters.

Taken as a whole, this book contains an immense amount of detailed information, systematically arranged, clearly presented, very full and up-to-date. It is adapted to meet the needs of students who desire to obtain a good chemical knowledge of the subject as well as to the use of farmers, who care only for the practical applications. The teachings of the author are conservative and are based on a broad consideration of all factors entering into the problems discussed.

Illustrated, 5 1-2 x 7 1-2 inches. 710 pages. Cloth. Net, $3.25

FARM MANAGEMENT

By W. J. SPILLMAN, D.Sc.

Consulting Specialist, U. S. Department of Agriculture

This book deals with the business problems that arise in the organization and management of the farm business. Its author is a practical farmer and a well known student and teacher of agriculture. The book was prepared primarily as a textbook for college students, but, with the exception of the rather technical chapter on the Law of Diminishing Returns, any one with a fair knowledge of farming will find the book more than worth reading.

The intending farmer's first problem is that of capital, and the first chapter deals with this subject. The reader will find in it much that is new, for this phase of farming has had little consideration. Several of the succeeding chapters are devoted to showing the past, present, and probable future position in American agriculture of our leading crops and types of farm animals. A great deal of attention is given to the factors that control types of farming in the various sections of the country.

Other chapters deal with the types of farm organization prevailing in different sections of the country, and the reason for them. Details of organization of many farms are discussed. The advantages and disadvantages of tenant farming are given full consideration.

The chapter dealing with the Law of Diminishing Returns in farming is unique. The author has recently discovered the mathematical formulation of this law, or really group of laws, for the law has at least three forms.

The last chapter outlines the subject of Marketing, as applied to farm products. This phase of farming is too complex for adequate treatment, even in a single volume, but the reader will find the chapter very suggestive. It at least outlines the problem and shows the studies that must be made before the subject can be treated as its importance demands.

One of the most important features of the book is its clear presentation of the reasons for the fluctuation in production and prices of farm products. Possible methods of preventing these fluctuations are discussed, and the difficulties in applying these methods pointed out.

The reasoning in this book is conservative and sound; yet the book contains more new matter than any other book that has appeared in a quarter of a century in the field of farm literature. We predict it will contribute more to a clear comprehension of American agriculture than any other book has ever done.

Not only will the book be of interest to farmers, but it will be helpful to specialists in all phases of agricultural science. It will help them to see the true position in farming of the phase of agriculture in which they are interested. Economists will also find much to interest them in the explanations given of the facts of American agriculture. The book shows that the business side of farming is much more than an application of economic principles.

Some idea of the scope of the book is given by the following list of chapter headings:

The Problem of Capital in Farming.
Extent of the Farm Enterprises.
Distribution of Types of Farming.
Status of Crop Enterprises—The Cereals.
Do., Hay and Forage. Cotton.
Do., Sugar Crops. Tobacco. Broomcorn. Vegetable Oil Crops.
Do., Fruit and Truck Crops.
Distribution of Livestock Enterprises.
Dairying.
Beef Cattle Enterprises.
Economics of Sheep Husbandry.
Hogs as a Farm Enterprise.
Economics of the Poultry Enterprise.
Farm Organization—Financial.
Do., Physical—The Farm Layout.
Business Organization of the Farm.
Farm Organization in New England.
Farm Organization in a Corn Belt Locality.
Farm Organization in the Cotton Belt.
Seasonal Distribution of Farm Labor.
Tenancy.
Law of Diminishing Returns.
Marketing Farm Products.

The book is well illustrated with charts and diagrams which present many of the most important facts of American farming.

Cloth. 6x8½ inches. 500 pages. Net, $3.00